

ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

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J. B. LIPPINCOTT COMPANY, PUBLISHERS

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ANNALS *of* SURGERY

VOL. LXXI

JUNE, 1920

No. 6

THE RELATIVE VALUES OF RADIUM AND SURGERY IN THE TREATMENT OF TUMORS OF THE PELVIC ORGANS *

BY JOHN G. CLARK, M.D.

OF PHILADELPHIA, PA.

THE logically developed principles underlying the modern operations for myoma uteri with their large life-giving and health-restoring factors, and a percentage, though small, of cures after a radical operation for cancer of the cervix and the large salvage after hysterectomy for cancer of the fundus, place these surgical procedures upon a plane of efficiency that commands our admiration. Just as old wine requires no bush, so a perfect method which yields faultless results may stand without support as the product of a perfected art or science. The choice of my title, therefore, has been made with the intent of forestalling any suggestion of surgical nihilism, for I am convinced, as the result of five years' experience in the use of radium, that we may consider it as an adjunct of surgery and not its competitor. The fact, however, that radium has worked so well in certain types of myoma uteri and has rendered so much easier the life of patients afflicted with incurable cancer, and further, that among these cases it has a definite percentage of survivors to its credit over the three-year period, with two individuals who have passed the quinquennial test, makes its unnecessary to offer an apology for making this novel form of therapy the subject of this address. In other words, our experience is such as to sustain the belief that in this instance the vintage of the modern surgical wine, although excellent, does occasionally require fortification, for this remedy is a most effective surgical coefficient, which, however, does not supplant surgical intervention but merely aids us in developing a well-balanced judgment in the selection of those cases best fitted for the more radical measures and those adapted to the safer and easier therapy.

The results in cancer of the uterus from the most radical operation, when we consider the small percentage of operability and the very high ratio of recurrence, will not stimulate a very antagonistic discussion against any substitute which may offer encouragement for relief or pos-

* Annual oration before the Philadelphia Academy of Surgery, delivered March 1, 1920. This address comprises the general subject matter of other papers which have appeared from the Gynecological Department of the University Hospital under the joint authorship of Dr. Floyd E. Keene and myself. The summary of cases includes only those treated in the University Hospital by Doctors Anspach, Norris, Keene, and myself.

sible cure of that large proportion of cases which fall within hopeless bounds so far as direct surgical intervention is concerned. On the other hand, as the proceedings of our various national societies attest, very strenuous opposition has arisen against radiation in myoma uteri. To the surgical enthusiast, this opposition is apparently well based, for during the last two decades the evolution of the operative treatment of this class of tumors has reached a plane of such scientific precision as to furnish the liveliest satisfaction, for the operations are attended by an exceedingly low mortality, and furnish a very large percentage of absolute cures and a small morbid residue. Our own experience in the Gynecological Department of the University Hospital very satisfactorily justifies our confidence in surgical intervention, for in our last series of 100 cases of myoma, in which hysterectomy has been performed during the last fifteen months, there was but 2 per cent. mortality, but notwithstanding this satisfactory issue, during that same interval, 110 cases have been radiated without mortality and almost without morbidity. We do not set one series of cases in antagonism to the other, but view both with equal satisfaction. The first represented the more hazardous risks, for it includes the large tumors and those associated with coincident inflammatory or other pathological lesions, whereas the second series comprise chiefly the small tumors causing hemorrhage and those cases of myopathic hemorrhage which in previous years have been subject to hysterectomy. To bring this question into clearer light for discussion, I shall consider, first, the use of radium in myoma uteri.

Myoma Uteri.—In the study of myomatous tumors, both in the consulting room, in the laboratory, and in the operating room, it has been fully attested that the symptomless tumor may remain quite innocuous over an indefinite period and finally after the menopause cease to be even a tentative menace, but the percentage of such cases is really very small in the final clinical summary of these cases. First, as to the various changes and degeneration which may take place in the tumor itself. Of these, the malignant change has probably been chiefly stressed as an argument in favor of attacking all growths of this nature as soon as diagnosed. That this fear has been enormously magnified has been proved in the study of over 850 cases in the gynecological laboratory by my associate, Dr. Charles C. Norris. A small ratio, not greater than 4 per cent., of cancer of the fundus may be found among myomatous uteri, but it is seldom, indeed, that these cases are not diagnosticated with great assurance on first consultation before even a curettage is performed.

A myomatous tumor is a constructive growth, merely building up in a disorderly fashion the normal muscular and fibrous tissues of the uterus. Consequently, so far as uterine bleeding is concerned, and this is the chief symptom upon which we rest our diagnosis of benignancy, it follows the normal physiologic law of periodicity. Therefore, when the normal menstrual flow is converted into a menorrhagia, even though stretched over

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several days, with clean-cut intermenstrual intervals of no bleeding or discharge, the clinical assumption in favor of benignancy is almost positive. On the other hand, cancer of the cervix or fundus is not of a constructive type of growth, but almost immediately shows a destructive activity in its earliest period of growth, and in creating its hemorrhagic symptoms deviates at once from the law of periodicity and begins to cause intermenstrual spotting, which very soon merges into a continuous flow with only the ebb and flood tide of the menstrual waves increasing and decreasing its output.

Almost with unerring precision, therefore, one may rule out cancer of the fundus except, in the earliest possible case through this interpretation of menstrual symptomatology. Menorrhagia is the hall mark of a myoma, regardless of its excess, whereas the tiny spot of intermenstrual blood is always a danger signal of cancer never to be considered carelessly. The criticism, therefore, that in treating myomata with radium, one may overlook cancer is not based upon clinical facts. Further, this error may be checked accurately by the diagnostic curettage, which should invariably take place in every case in which there is the slightest suspicion of this complication. Should the pathologic report show the presence of a coincident cancer of the fundus, a hysterectomy may be performed before the patient leaves the hospital. In such an event, the use of radium does not prejudice either the immediate surgical or remote curative result, for it has struck a very effective blow against the cancer, which combats its further distribution through metastasis, and especially serves when the hysterectomy is performed as a splendid prophylactic agent against the implantation of actively growing cells in the freshly exposed tissues. In its action, radium strikes immediately and effectively all carcinomatous cells within its radius and like stricken plants which may not wither for a few days are, nevertheless, rendered incapable of further growth or propagation.

Through selective differentiation as controlled by our laboratory findings in myomatous tumors, we are much more concerned by one or two of the benign retrogressive changes in myomata in their relations to radium therapy than by the malignant changes which may certainly be recognized and properly dealt with. A simple liquefaction process, or hyalin change, may be taken care of very satisfactorily by gradual absorption; a true necrosis, however, gives rise to toxic by-products, which seriously influence the patient's health.

One not infrequently finds in certain myomatous cases a degree of anæmia not balanced for by the loss of blood, the patient's complexion appearing more like that of cachexia than that which occurs in an uncomplicated anæmia; and furthermore, there is an asthenia of a toxic type which is not satisfactorily accounted for by a simple blood loss. Seldom, indeed, in such instances is a malignant condition encountered, but not infrequently varying stages of degeneration of the tumors are discovered on macroscopic section marked by a grayish-purple or slaty discoloration

or actual gangrene in some of the tumors, indicating a partial or complete necrosis. In others an extensive liquefaction necrosis is noted. Through the absorption of these necrotic or degenerating materials, serious inroads on the patient's constitution have occurred and a rapid healthful rebound follows a hysteromyomectomy. Based on these observations, we cannot look with favor on the conversion of large tumors through radiation into retrogressive tissues, which through absorption may cause toxic symptoms, hence our limitation based upon the smaller sizes of the tumors has been established. When the tumor is large, as we have hitherto noted, the patient may serve as the sarcophagus for her decadent tumor. Also, these large tumors are very frequently associated with or, through pressure, have produced other lesions, especially of the inflammatory class. Frequently pressure symptoms have forced the patient to consult the surgeon, and there may be no variation of the menses from the normal. In such cases the tumor may be a pure fibroid, largely of a dense hyaline or calcareous type, certainly not quickly responsive to radiation.

For these, and still other reasons, therefore, we find no evidence thus far in our experience to convince us that the large tumors should not be removed by approved surgical methods. In no instance has there been so quick a decrease in the size of even the smaller tumors as to justify us in believing that the larger tumors which are giving pressure symptoms will diminish sufficiently rapidly in even six months or a year to give satisfactory relief. We stand, therefore, on the general principle against radiation in tumors larger than a three or four months' pregnancy, and in only the exceptional case do we deviate from this rule.

The next danger—that of sarcomatous transformation of the myoma—is also stressed with much gravity by many writers; but the cold laboratory records very greatly chill this side of the discussion. The fact is that sarcoma is seldom a degenerative or concomitant evil of myoma. If it were as common as is asserted by some of these alarmists, out of every series of 100 supravaginal hysterectomies, as usually performed by American surgeons, a definite percentage of recurrent sarcomas in the cervical stump should be encountered. In more than 1000 hysterectomies performed in the Gynecologic Department of the University Hospital such a sequel of a supravaginal hysterectomy has been observed but once. In a review of 816 myomas in our laboratory by my associate, Dr. Charles C. Norris, he finds 25 sarcomas, only 13 of which were not diagnosed clinically at the time of operation. Based both on clinical and on laboratory conclusions, therefore, we deal with fears solely within the domain of fallacious supposition in discussing the dangers of sarcomatous changes in myomas and fibromas. Even were these fears justified in a much larger measure, there would still be no argument against the use of radium, since these tumors react most favorably to this influence.

Through an experience with nearly two hundred cases, including myomata chiefly and a smaller number of myopathic hemorrhage, we

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have established for ourselves a very definite rule of elective procedure. As to the cases which we do not radiate, we may classify them as follows:

1. The larger tumors; as measured by the size of the pregnant uterus, the maximum being that of a three or four months' pregnancy. There are a few exceptions to this rule as marked ordinarily by decided surgical contraindications, such as grave heart lesions, greatly diminished renal function, and other serious constitutional defects which ordinarily render an operation unduly hazardous.

2. All tumors with symptoms of associated inflammatory lesions, indicated chiefly by unilateral or bilateral pain. This contraindication to radiation is based upon the fact that old inflammatory lesions may be stimulated into renewed and dangerous activity. In three or four instances, this distressing complication has followed radiation in these cases.

3. In patients with normal or slightly increased menstruation who present a cachectic appearance and are the subjects of toxic symptoms out of proportion to their anæmia.

4. In all cases in which there are symptoms of other coexistent abdominal lesions, such as cholecystitis, cholelithiasis, appendicitis, etc.

With these four classes still held within the surgical domain, we treat only the tumors of smaller sizes, causing hemorrhage as their chief symptom, and all cases of myopathic hemorrhage. Of all patients, the latter respond most quickly and satisfactorily to this remedy. Under the limitations just enumerated, we may with the greatest assurance predict a very satisfactory course for cases falling within the restricted domain. The great advantage of this plan of treatment over either X-ray treatment or major surgical operations is its simplicity and safety. The patient undergoes the simple preparation incident to a curettage. Nitrous oxide anæsthesia is administered, the cervix is well dilated, the uterus curetted if there are symptoms of possible malignant change, and fifty milligrams of radium introduced according to the method described in other papers hitherto published. The use of an anæsthetic makes more accurate the diagnosis and safer the application. The subsequent events in the recovery of the case follow with clock-like regularity; five days in the hospital, about six weeks of variability as to the flow, in some this symptom may persist or even temporarily be excessive, in others ceasing abruptly, never to recur. After the hemorrhagic phase is over, there is a brief period, as a rule not over ten weeks from the time of radiation, of a slight sticky yellowish vaginal discharge, seldom profuse and never offensive. This concludes the symptomatology as it relates to the uterus after radiation.

Menopause.—The change of life in these cases varies in its phases, as the constitutional and temperamental characteristics of women vary. In this connection one might employ the lines of the comic opera librettist: "There are never two women alike, and never one woman alike twice." In the more marked grades of anæmia we believe the climacteric change is

more abrupt and attended with more pronounced symptoms. This may be explained on the theory that the hematogenous system has been working for weeks or months at a great speed in corpuscular generation, since the continuous loss of blood is so great that this excessive deficit must constantly be remedied. A quick check on this great activity must in many instances jar the physiologic equilibrium and thus induce a more acute menopause. So far as we are able to judge, we believe that the menopause is somewhat more trying to the average woman under an abrupt cessation than when she drifts into this change more naturally. In estimating the possible objections to radiation this symptom may possibly be classed in this light, although it in no way differs from the same sequel after a hysterectomy in which the ovaries are removed. In general, we find our patients are very enthusiastic over their results, and count this possibly trying symptom as of light moment compared with their satisfaction over an escape from an operation.

Failure to Relieve.—Of our series of over 150 cases, we have failed to relieve four patients sufficiently to satisfy them or ourselves, and we have subsequently resorted to a hysterectomy. Two patients have been operated upon in other clinics. So far as we have seen, no disadvantage has occurred from the preliminary radiation, as all of the patients except one upon whom an operation has been performed have recovered without complications.

The course of events just depicted is that noted in women nearing or in the menopausal years. In younger women, we employ radium much less frequently than we operate, because these cases may be eligible for a simple myomectomy or a subtotal hysterectomy, which leaves the generative organs essentially normal in the first class, and there is a more stable physiologic equilibrium after an operation in the second. When we resort to radium in younger individuals, it is never employed in maximum dosage, but is started at a low point of intensity free from the danger of bringing on the climacterium. It may, therefore, require a second and possibly a slightly stronger dosage to check an excessive flow. In younger patients we study with particular care the symptomatology and its underlying pathology, for there is just as much danger in these individuals from the unbridled use of radium as that following the heedless surgery of the overzealous or injudicious ovariectomist. As a concluding comment upon this aspect of radiation, we may express the greatest enthusiasm as to the results obtained in a large series of cases, now over 200. Time is proving the cures permanent and free from any sequelæ, which in their later phases might stand prejudicially against the treatment.

Cancer of the Uterus.—From the beginning of our use of radium in the Gynecological Department of the University Hospital in 1914 up to January, 1919, over one year ago, when our last summary was made by Doctor Keene and myself, we had treated 209 inoperable cases of cancer of the uterus with the following results:

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	Dead	Not traced	Living
1914	8	0	1
1915	19	1	4
1916	46	8	11
1917	33	3	23
1918	5	13	34
Total	111	25	73

No cases treated within one year before this tabulation have been enumerated, as we are now looking towards the ultimate rather than immediate results. Since the above tabulation was made at least two of the patients treated in 1915 have gone over the five-year period and are living and free from recurrence.

We regret that we are unable at this stage of our report to give a more complete summary as the number of patients not traced is accounted for by the facts incident to war—first, the decreased number of our hospital staff rendering it impossible to keep our follow-up system abreast of the times. Further, the nomadic tendency of an urban population, due to the recent fluctuation of our industrial systems and the disturbance incident to the housing situation, makes it exceedingly difficult to keep track of a continuously mobilizing population. In endeavoring to trace our patients we have found not infrequently a change of three or more addresses within a few months after their discharge from the hospital. Notwithstanding these discrepancies in our reports, the showing in this series is rather remarkable, and we have been greatly encouraged to find so large a number of patients, all of whom fell within the inoperable class, still living and apparently well many months subsequent to their last treatment. Some of these cures have been startling, and we are now justified in our hopeful forecasts for a few permanent cures and we know beyond cavil that the palliative results have been far and away better than that following any therapeutic measure hitherto employed. In reviewing our results from radium therapy, we find that same bizarre tendency as noted in our previous surgical experience with cancer. From the appearance or even the extent of the disease no one can forecast with assurance the probable outcome of treatment. When surgical measures are invoked, one frequently ends an operation with a great degree of optimism as to a cure, because the disease has apparently been well circumscribed and has shown no demonstrable metastasis, and yet within a few months has again appeared with renewed violence at the local site of operation, while in another case in which the frontier zone of the growth has not satisfactorily been encompassed and the prognosis is bad, the patient may remain free a long time from recurrence or even may be cured. This same peculiarity has been noted in our radium experience. Thus in our 9 cases treated in 1914, the one living patient discredited every forecast and survives to-day and is to all appearances cured despite a very extensive and a very vicious type of cancer. A young woman

under thirty years of age was taken into one of our hospitals in almost a moribund state from a massive intraperitoneal hemorrhage, incident to a large perforation of the fundus of the uterus from a decidoma malignum. The surgeon was compelled because of the critical state of the patient to perform a rapid supravaginal hysterectomy. Her convalescence was slow and she left the hospital in a very precarious condition, and was again readmitted six weeks later almost ensanguinated from a massive vaginal hemorrhage. On examination, a large fixed mass was found in the left side of the pelvis and a deep irregular crater occupied the site of the cervix. A hasty cauterization was done to save her life. Notwithstanding the hopeless outlook, two applications of 100 milligrams of radium were made at a six weeks' interval. After the first radiation the bleeding ceased and her recovery was nothing less than astounding. This patient has passed her five-year period and is now well and actively engaged in her household duties and has adopted a child. A very brilliant argument could be constructed in favor of radium were we to let this case occupy the centre of the limelight, but surgery has just as remarkable instances of unexpected cures when the issue appeared as hopeless and we must, therefore, turn to a summary of all cases in order to find a judicial equilibrium. In these startling cases, however, we feel that there may be further pointers towards still better results. Possibly through the use of radium or its emanations carried into the depths of a growth a further advance may be made. At least these remarkable cases furnish a further sustaining argument in favor of the cure of cancer so long as the process is still localized and without metastasis when it is attacked either by surgical means or radium.

Other cases in our series are equally noteworthy, but it is not our purpose to lay great stress upon these highly gratifying isolated instances, but to base our discussion upon the influence of radium in those patients who are not healed. Time will soon establish the question of final cures. In the meantime we feel that a very important advance has been made in the palliative treatment of even the hopeless cases. Thus, in our large series, hemorrhage has been stopped for a considerable period in a very large percentage, in many never returning, in others reappearing at variable periods before the death of the patient. In others it has been notably lessened and but seldom not influenced. No argument is required to sustain this beneficent palliation in these fear-stricken women, for to those who witness this relief the results are self-evident. The malodorous discharges are likewise blotted out in a considerable proportion of cases. In its palliative influence on pain we cannot claim so much, and yet it frequently acts most happily in this direction. In radium cases, as in surgery, however, we must meet the same lay criticism as well as professional pessimism in those instances in which pain is not relieved after radiation or comes on later in the course of the inoperable case. Frequently, this acute terminal agony is charged up to

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the account of radiation by relatives or friends of the patient and occasionally this same objection to the use of this novel remedy is sustained by the family physician. Every surgeon knows that surgery is likewise condemned under the same conditions. In all propaganda work, therefore, among laymen as well as within our professional circle, the fact should be dwelt upon that while cancer in its earlier stages is always painless, in its terminal stages it is nearly always agonizing. In only this way may these false assumptions be overcome concerning any remedy which fails.

In the occasional case in our series in which the pain has been especially severe, we have felt that possibly there might be a decided suspicion in favor of this hypothesis and yet within a few days another case may be seen with identical symptoms in which no treatment whatever has been applied. Even admitting this possibility in the occasional case, the many others which have found relief from pain easily overbalance these objections.

Finally, are there any untoward sequelæ chargeable to the radium account? Two are possible. First, does radiation produce pain shortly after the first or second sitting? Occasionally it does. In anticipation of this possibility, we warn the patient not to be alarmed should it occur, for in a small percentage of cases notwithstanding every care exercised in the protection of the rectum a very acute proctitis may follow. In such cases a decided stranguary may be noted at variable intervals from a few days to three or more weeks after radiation. Mucus and even blood may be discharged and the pain may be so severe as to require hypnotics. In some cases opium suppositories may be necessary to quiet the patient. In others a mucilaginous suspension of bismuth subnitrate by rectal injection may be quite sufficient to soothe the pain. In general, however, this symptom is the exception rather than the rule, and will be noted with increasing infrequency as precaution is observed in the protection of the rectum and bladder. Much less frequently is vesical tenesmus noted and, as a rule, it is of a more evanescent type.

As to fistula we have noted 17—9 rectovaginal and 8 vesical. By no means should all of these fistulæ be charged to radium, for in over 200 cases of inoperable cancer which are not treated, certainly this terminal event will occur in a large number of patients. We are convinced, therefore, that such distressing phases of cancer of the cervix are actually prevented, for in the large number of cases which were locally healed of deep ulcerating cervical craters, there has been no further trouble in this locality, and in most of the patients who ultimately died the end came through metastasis or deep pelvic extension.

Briefly stated, therefore, we see in the use of radium in inoperable cases of cancer a greater tendency to relieve pain than to produce it, and also a smaller percentage of fistulæ after its use than in the patients going to their death untreated, or in which various palliative operations are

performed or the actual cautery is applied. Through the results achieved by radiation in this group of inoperable cases, the question is forced into the foreground—Shall we abandon the radical operation in all cases in favor of radiation? As yet, we may not wisely answer this question. Certainly the questionable operative case must be transferred to radium therapy. In the definitely operable case with a well circumscribed area and no broad ligament extension, we still advise hysterectomy. We base this adherence to operation upon the certainty of a definite percentage of cures obtained through surgical intervention. On the other hand, the transfer of every questionable case to the group for radiation is based upon the certainty of a large surgical mortality in the event of an operation, the frequency of disabling sequelæ and the distressingly high percentage of recurrence after even the most radical operation.

Thus far we know that radium greatly supplements surgery and within the next five years it may possibly supplant the radical operation in even the early cases.

Finally, as to the question of operation after radium has apparently reduced the inoperable to an operable stage. Upon this issue we see no reason in favor of this plan. We feel convinced that surgery can accomplish nothing further in such cases. To the contrary, we believe that surgical intervention is most hazardous. The connective tissue contractions in the vaginal vault and parametrium incident to radiation must render the dangers of injury to the bladder, ureters, and rectum greater, and the disruption of connective tissue which may actually have encapsulated the carcinoma may lead to a reimplantation of malignant cells, which may have been held in leash or actually have been rendered innocuous. On the other hand, in the actually operable cases we commend and now follow the plan advocated by Howard Taylor. He radiates all operable cases a few days before hysterectomy is performed. This appears most logical for the operation quickly follows before the actual destructive changes have taken place, and in his experience he finds no increase in the difficulty of a panhysterectomy. This, however, is a very different proposition from that offered after a deep crater has apparently been healed and upon its site dense hyalinized connective tissue has formed which drags the base of the bladder, ureters, and rectum into close juxtaposition.

From our summary of 209 cases we find no cause for discouragement, for we have seen splendid palliative results from radiation, and we think it possible that with a further development of technic, cancer of the cervix may be removed from the surgical domain. Should this transfer become feasible, we are sure we shall find few dissenters among surgeons, for certainly we have no grounds for optimism from a radical operation in the pathetically small percentage of operable cases. For every case which may with reason be submitted to operation at least ten will fall by the wayside because they apply for help too late. To these wretched sufferers radium offers a palliative boon and even a possibility of cure. In cancer of the fundus

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the results are too satisfactory to be abandoned in favor of radium, although in at least four cases we have witnessed a very favorable outcome in patients in whom there were grave contraindications to surgical measure. In two instances a cure appears to have been effected. For patients, therefore, suffering with complications prohibiting an operation, radiation offers a decided hope, for in no anatomic situation may we so certainly secure the full force of the radium without ill results. The force of the emanations are chiefly confined to the fundal cavity and the muscular uterine walls shield other organs from injury.

Two years ago we presented a summary of results in 100 cases of inoperable cancer of the cervix and female genital organs treated in the Gynecological Department of the University Hospital, and arrived at the following conclusions:

"1. As a palliative remedy radium is the treatment par excellence in inoperable cases of cancer of the cervix.

"2. In border-line cases in which formerly we accepted the grave risks of an operation in the hope of eradicating the disease, we now employ radium, but in the certainly operable class we still advocate a radical operation followed by post-operative radiation.

"3. In cancer of the fundus, even when far advanced, we perform a hysterectomy, resorting to radiotherapy only in the face of grave operative contraindications."

In view of our further experience, we now feel that our fourth conclusion, as then set forth, may be modified by a limited claim for actual curability. It was as follows:

"As yet we claim no cures, but, based upon the observation of a considerable number of inoperable cases which have remained locally healed from one to three years, we venture the hope that the quinquennial test will find several survivors."

Results of Radio-therapy in 209 Cases of Cancer of the Female Genito-urinary Organs, Treated in the Gynecological Department of the University Hospital during the Years 1914-1918

1914	
Living (4 years 4 months)	1
Dead	8
2 months	1
5 months	1
6 months	1
12 months	1
21 months	1
2 years	2
3 years	1
1915	
Living	4
3 years 3 months	1
3 years 10 months	1

JOHN G. CLARK

3 years 6 months (urethra)	1
4 years (chorio-epithelioma)	1
No report	1
Dead	19
3 months	2
5 months	1
6 months	1
4 months	1
12 months	3
10 months	2
13 months	1
20 months	1
4 years	1
4 years 2 months (died from T. B.—no recurrence)	1
2 months (labia)	1
19 months (vagina)	1
19 months (urethra)	1
2 years 4 months (vulva—died from endothelioma of lung—no local recurrence)	1
Carcinoma of fundus—died from heart disease few months after application	1

1916

Living	11
2 years 5 months	2
2 years 9 months	2
2 years 10 months	1
3 years	1
3 years 1 month	2
3 years 3 months	2
3 years 6 months	1
Well for 22 months and then not traced	1
Well for 5 months and then not traced	1
Well for 2 years and 4 months and then not traced	1
Well for 1 year 2 months and then not traced	1
Well for 2 years 5 months and then not traced	1
Well for 2 years and then not traced	1
Well for 2½ years and then not traced	1
Well for 3 years and then not traced	1
Dead	46
1 month	1
3 months	4
4 months	2
5 months	3
6 months	4
7 months	1
8 months	3
9 months	1
10 months	1
12 months	5
13 months	3
14 months	4

RADIUM IN PELVIC TUMORS

18 months	2
20 months	1
21 months	2
19 months	2
2 years	2
2 years 2 months	1
2 years 3 months	2
1 year 8 months (fundus—death from cerebral embolus)	1
6 months (vulva)	1

1917

Living	23
3 months	1
4 months	1
5 months	1
6 months	1
11 months	1
12 months	2
14 months	1
15 months	1
17 months	2
21 months	1
2 years	1
2 years 4 months	1
9 months (fundus)	1
16 months (fundus)	1
17 months (fundus)	1
18 months (fundus)	1
11 months (vagina)	1
16 months (vagina)	1
21 months (vagina)	1
Not stated	2

Dead	33
4 months	5
5 months	3
6 months	2
7 months	2
8 months	1
9 months	3
10 months	1
11 months	1
12 months	2
13 months	4
14 months	1
17 months	1
26 months	1
5 months (vagina)	1
11 months (fundus)	1
11 months (urethra)	1
12 months (fundus)	1
14 months (vagina)	1
Not stated	1

JOHN G. CLARK

1918

Living	34
1 month	1
2 months	6
3 months	1
4 months	2
5 months	2
7 months	2
8 months	5
9 months	1
10 months	1
11 months	1
12 months	2
14 months	2
3 months (fundus)	2
11 months (fundus)	2
12 months (fundus)	1
4 months (vagina—following hysterectomy)	1
12 months (vagina—following hysterectomy)	1
14 months (vagina—following hysterectomy)	1
12 months (chorio-epithelioma)	1
No report	13
Dead	5
2 months	1
5 months	1
9 months	1
10 months	1
11 months (fundus)	1
Hemorrhage	209
Stopped	132
Lessened	26
Uninfluenced	13
Not stated	38
Leucorrhœa	209
Stopped	85
Lessened	26
Uninfluenced	28
Increased	14
Not stated	56
Pain	209
Relief	49
Unrelieved	34
Lessened	8
Pain not present at time of first radiation	118
Fistulæ	17
Vesico-vaginal	8
Recto-vaginal	9

AMPUTATION OF THE LEG

By O. BORCHGREVINK, M.D.

OF CHRISTIANIA, NORWAY

SURGEON TO DIAKONHJEMMET

THE patient, who is going to have his leg amputated, can claim a correctly performed operation, which gives the best possible conditions for the effectiveness of the prothesis. What the surgeon can do, is to secure primary healing, a good end-bearing stump by osteoplastic or aperiosteal operation and with a view to the solidity of the artificial limb amputate at least 21 to 22 cm. from the ground. The maker has to produce a solid appliance, which fits exactly. This means that repair and renewal of the artificial limb will take place with the longest possible intervals, and that its pressure is rationally distributed. The bucket must, without painful pressure, find so good support on the upper part of the leg, that the end of the stump escapes the bearing of a too heavy weight. At all events the leg alone should be able to bear the weight of the body, with the result that the patient, if he so desired, could walk comfortably and well with a free knee-joint.

Every leg stump has, however, several weak points and the shorter the stump the more pronounced. It offers, for instance, few and too steep bearing surfaces. The artificial limb finds its chief support in the inner tuberosity of the tibia, the inner surface of which in its lower part forms an angle with the axis of the leg of about 30, in its upper part of about 20 degrees. The internal tuberosity projects, in the naked bone, 1.5-2 cm. inside the inner tibial border, but in the living this projection is reduced by the tendons of the sartorius, gracilis and semitendinosus muscles, with the result, that only the upper and steeper half of the tuberosity remains as a free bearing for the fitting.

The tibia possesses another but still less valuable bearing in its tubercle, the most prominent point of which projects 0.5 cm. in front of the tibial crest. With the latter the lower and sloping part of the tubercle forms an angle of only 8 to 10 degrees. The slight bearing capacity of the tubercle of the tibia is still further reduced by the absence of a corresponding bony support on the posterior surface of the calf.

The internal tuberosity of the tibia has, on the contrary, a corresponding osseous *vis-a-vis* in the head and the neck of the fibula, on which the weight of the body will rest as heavily as on the internal tuberosity. But the amputated fibula is very unsuited to bear this weight. The artificial limb will press the lower half of the bone through the soft parts against the lateral border of the tibia. The result will be, that only the upper part of the bone, especially its neck and head, lying on a level with the projecting surface of the internal tuberosity of the tibia, will be exposed to the pressure resting on the lateral side of the leg.

As the fibula moreover forms a steep incline of about 10 degrees with the axis of the leg, the upper edge of the bucket without being stopped by a prominence of any importance will slide upwards, until the lateral pressure against the fibula becomes so great, that further ascent is prevented (Fig. 1).

But this is not all. The considerable pressure that obviously is proportionate with the weight of the patient will be potentiated, because it, instead of being distributed over a larger surface, rests on a narrow ridge, which, moreover, is padded by no other soft tissue than the skin and the superficial fascia. To make matters still more unfavorable, the peroneal nerve crosses obliquely the neck of the fibula. As a consequence of these anatomical conditions the pressure of the artificial limb will often be followed by neuralgic pain, periostitis of the neck and head of the fibula and excoriations of the skin.

The inconvenience, which the pressure of the artificial limb on the fibula produces, is to many amputated a constant source of suffering. If the leg had to bear as much of the weight of the body as desirable for easy and steady walking, the troubles would become still worse or totally unendurable. The artificial limb-maker does accordingly the only thing he has to do. He makes a compromise with the patient as well as with his own demands for an effective fitting. He carves out a deep concavity for the fibula in the leg bucket, so that its pressure on the fibula disappears, or at any rate, becomes endurable. Or he makes the thigh bear the greater, or nearly the whole, weight of the body. This explains the unsatisfactory gait, which at least in our country is too common after the amputation of the leg. The capacity of enduring pressure on the fibula is likewise the reason, why men usually walk less well in their leg fittings than women, who on account of their lighter weight and richer subcutaneous fat can bear a greater pressure on the leg than the heavier and mostly leaner men.

A removal of the tender part of the fibula seems a natural way to overcome the difficulty. It has also been tried but without being used to any extent. By the removal of the head and neck of the fibula the peroneal nerve no doubt will sink down into a hollow and be protected from pressure. But instead of pressing on the neck and head of the fibula the leg bucket will ascend from the fibula shaft upwards on the *lateral* surface of the external tuberosity of the tibia, which certainly is more able to stand pressure but offers practically no support. If the bucket is required to fit only approximately, the outer tuberosity of the tibia will have to bear a considerable lateral pressure and moreover be exposed to constant sliding of the fitting, and soreness of the skin will be inevitable.

A totally different result is obtained by the removal of the whole fibula. One has every inducement to take this step. Firstly, the fibula has no other function than to form the adaptable external malleolus, the spring of which its shaft represents, and after the amputation the bone has lost every *raison d'être*. Secondly, the amputated fibula is a hindrance to a rational artificial limb. Thirdly, the removal of the fibula sets the best bearing points of the

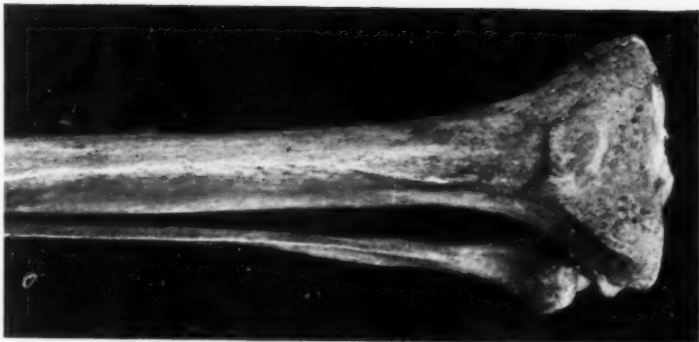


FIG. 1.—Showing the steepness of the inner tuberosity of the tibia and how the fibula is a hindrance to the use of the external tibial tuberosity as a bearing surface.

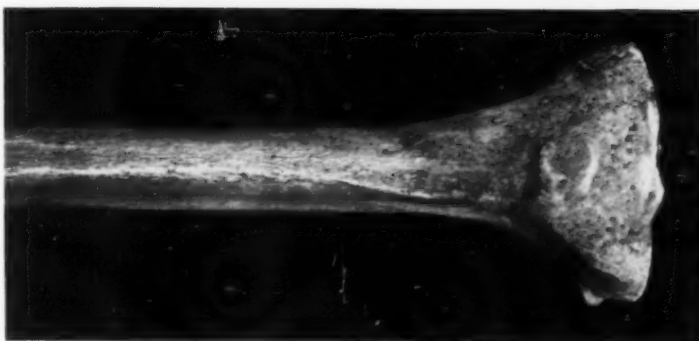


FIG. 2.—Front view of the tibia showing the greater projection and lesser steepness of its external tuberosity. Showing also its value as a bearing surface on account of its situation opposite the inner tuberosity and on a level with it.

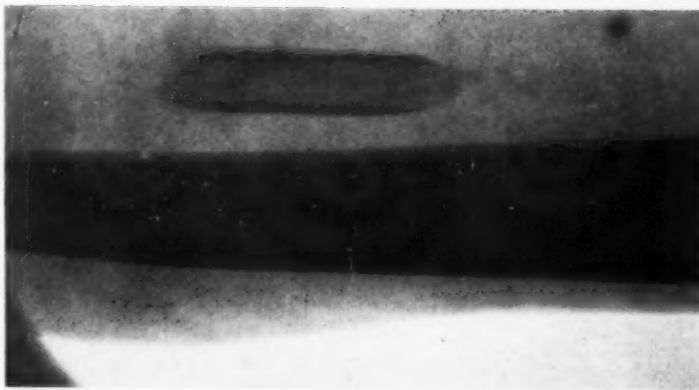
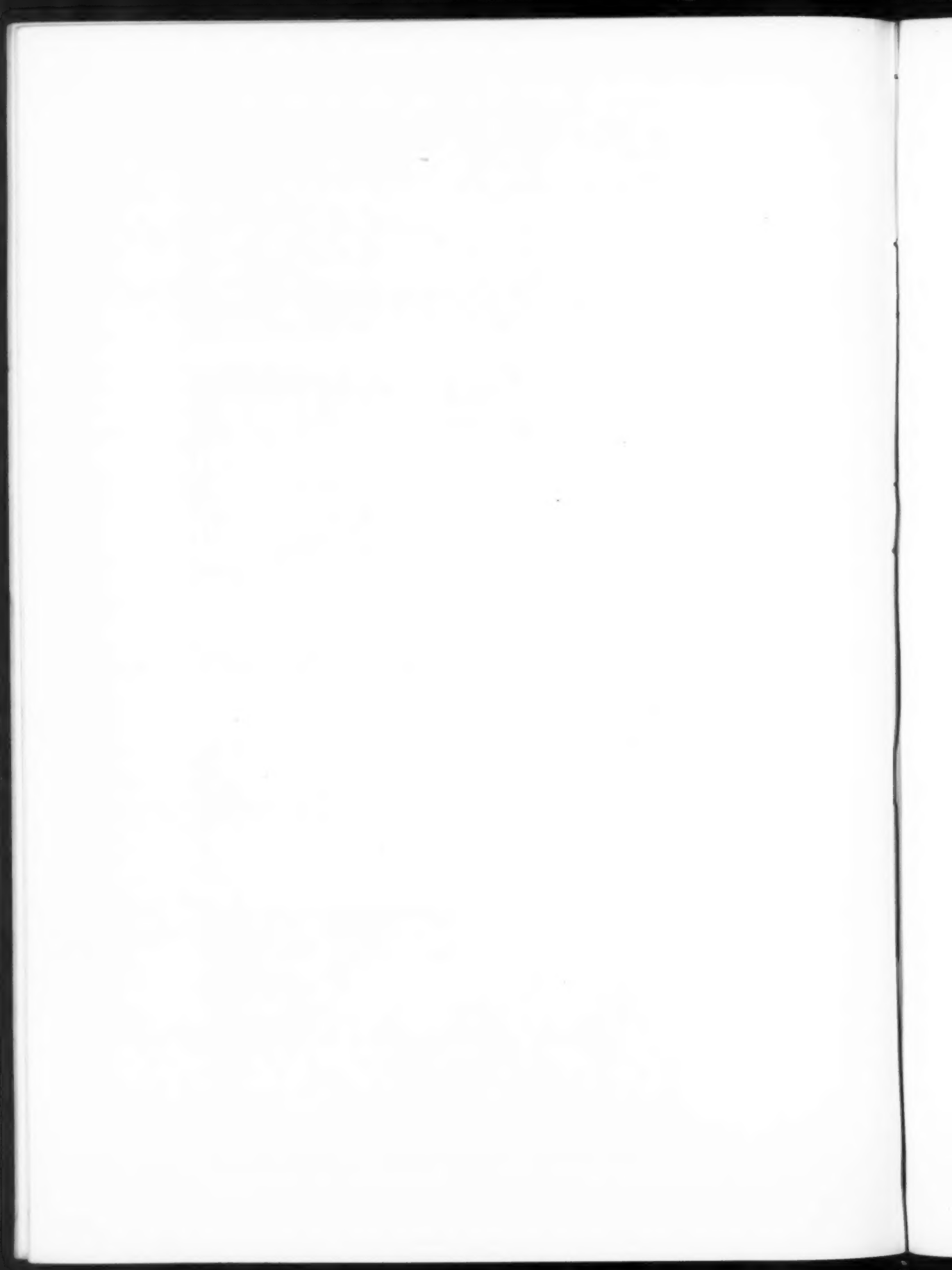


FIG. 3.—Photograph of roentgenogram of the tibia after disarticulation of the fibula. A 5 cm. long piece of the lower part of the fibula has been left to prevent the leg bucket to slip downwards.



FIG. 4.—Photograph of the leg stump three years after amputation of the leg and disarticulation of the fibula.



AMPUTATION OF THE LEG

leg at liberty, as the excellent bearing surface which the tibia possesses in its external tuberosity will now be able to give a very perfect support for the free edge of the leg bucket.

For the external tuberosity of the tibia forms a considerably greater projection than the internal tuberosity does on the opposite side. On the naked bone the external tuberosity projects 2.5 to 2.7 cm. It forms further an angle with the axis of the bone, on an average of 65 degrees, or nearly three times as great as the angle between the shaft and the effectively bearing part of the internal tuberosity. The outer tuberosity moreover has in its lateral part the flat articular facet for the head of the fibula. This facet extends to the periphery of the tuberosity and is 10-13 mm. in diameter, or about the half of the projection. An advantage, which ought not to be ignored, is that the articular facet, on which the greater part of the pressure of the fitting will rest, in its quality of articular surface, is destined by nature to stand pressure and therefore is more able to bear than any bony part covered with periosteum. The lateral tuberosity will do excellent service as a bearing point also because it is situated opposite the internal tuberosity and on a level with it. As the strongest bearing surfaces of both tibial tuberosities are situated outwards and posteriorly, the fitting obtains a posterior support, which allows it to rest also on the inferior slope of the tubercle of the tibia. This slight prominence becomes therefore after the removal of the fibula a bearing point of real value (Fig. 2).

Let us sum up the practical advantages from the disarticulation of the fibula. In the first place, we meet with the disappearance of the tenderness on the neck and head of this bone. Secondly, comes the equally valuable isolation of the lateral part of the head of the tibia, whereby the fitting instead of ascending on the fibula will find corresponding internal and lateral bony prominences, under which its upper edge can rest. A third advantage is, that the amount of direct pressure upon a non-tender stump of the tibia under these circumstances may be accurately decided and that the end-bearing capacity of the stump can be made practically useful.

To the patient, who knows by personal experience the discomfort that follows the ordinary amputation of the leg and wearing of an artificial limb, a promise of reduction of pain will be a sufficient temptation to allow a disarticulation of the fibula. This feeling gives itself expression in the willingness with which previously amputated patients accept the proposal of this reoperation hitherto unknown to themselves and to the profession. The result of the first walking test will also convince both patient and limb-maker, that the new-found comfort, in itself, more than justifies the operation. But the surgeon must for the benefit of this comparatively numerous class of sufferers aim higher. It must be to him an object of importance to combine ease with increased capacity and endurance in walking. In this respect the extensive broad and favorably situated bearing surfaces of the head of the isolated tibia, combined with a good stump, will in most cases prove able to bear the whole weight of the body. In this case the patient

under favorable circumstances can use an artificial limb without a thigh fitting and with a free knee-joint walk with greater comfort and considerably better than any patient after amputation of the leg has been able to do up to the present.

The walking without a thigh bucket depends to a great extent upon the length of the stump. The longer the stump the firmer it sits in a leg fitting, and the less the bucket will slide away from the bearing surfaces of the tibia. A short stump cannot find sufficiently firm support only in a leg bucket, and a thigh fitting will be indispensable. But as we are practically never allowed to amputate below the middle of the leg, it must appear desirable to place a resistance to the tendency of the stump to slide up and down inside the bucket. A greater circumference of the lower end of the stump than of its middle part would in this respect be a practical and effective measure. I have tried to obtain this advantage by leaving a 5-6 cm. long piece of the lower end of the fibula (Fig. 3).

It may be asked, whether the results of the disarticulation of the fibula have equalled expectations. This can in certain respects be answered decidedly in the affirmative. The walking becomes painless and consequently more easy. Several patients, who previously could use their artificial limb only now and then, and who mostly were incapacitated for work, have after the removal of the fibula been able to walk quite naturally, without the slightest limp, and to resume regular work and stand practically any bodily exertion. All my reamputated patients think their condition considerably improved; some of them declare that they are leading a totally new life.

In one respect I have not yet achieved a satisfactory result. The problem of constructing an artificial limb adapted for the new form of the leg stump, which is a natural consequence of the disarticulation of the fibula, is still far from being solved. As after the amputation of the leg the postoperative changes of the stump do not terminate in less than $1\frac{1}{2}$ -2 years' time, we are only for a minority of our patients arrived at the stage, when the artificial limb can be made in a form to be used for a considerable period without alteration. Another, and not at all insignificant difficulty, is to train the makers of artificial limbs in the manufacturing of a fitting so different from the usual. Add to this the unsurmountable difficulties which war-time has caused in several respects. It is only a natural consequence of these conditions that the artificial limbs, which I have up to the present received, must be considered more as experiments than as final results (Fig. 4).

The principles of the artificial limb, required by amputation of the leg with disarticulation of the fibula, can, however, be spoken of with accuracy. Up to the present the great desideratum for a leg fitting has been to avoid painful pressure; in the second line came the demand for a certain amount of bearing capacity by support on the upper extremity of the leg. For these two purposes an excavation of the bucket corresponding to the neck and head of the fibula and a prominence below the internal tuberosity was all that was asked for as regards the leg fitting. The remainder was left to

AMPUTATION OF THE LEG

the thigh bucket. When the fibula is removed, the upper edge of the leg bucket has, like a ring, to be slipped upwards over the stump of the tibia, until it is stopped by its tuberosities projecting on a level with one another. But here it must fit. Not approximately but accurately. Each part must bear its share of the pressure. Not too little, because then other bearing points get more to bear than they should. And not too much, because that means discomfort. The upper edge of the leg bucket ought to be as wide as the corresponding projection of the inner and outer tuberosity. In front a little notching should make it rest under the tubercle of the tibia, and the posterior third of its circumference must be slightly widened to lie loosely on the soft parts of the calf. Every bearing point must be employed, then the object should be to make the tibia bear the whole weight of the body, and not even the best end-bearing stump can do this alone. But thanks to the considerable bearing capacity which both tuberosities united possess, this is not necessary. The stump has only to take its share.

How can the upper edge of the leg bucket be made to fit as accurately as desired? It can not be done by the usual plaster cast. This will be a very imperfect counterpart of the details of the bearing surfaces. By a wooden bucket it is perhaps obtainable, but only when it is made by a very skilful and experienced fitter. The easiest way to accurate fitting is to mould a bucket of a plastic material on the upper extremity of the tibia and then to harden it in the form thus acquired.

An amputation of the leg should be based upon the following lines:

The fibula is to be removed. The scar has to be so situated as to escape pressure from the prosthesis.

Avoid ligating the large vessels, which means interference with the nutrition of the flaps. Separate the tendon of the biceps muscle and other soft parts from the fibula as close to the bone as possible without injury to its periosteum and without injury to the insertion of the same tendon into the external tuberosity of the tibia.

Close the incision through the superficial fascia carefully by suture. Every part of the stump ought to be covered by the fascia.

The tibia ought to be divided at the lowest possible point but not lower than 22 cm. from the ground. A practical rule is to divide it at the middle of the leg.

The stump of the tibia should be treated according to Hirsch-Bunge. The scar should not pass over the end of the tibia but should be situated posteriorly and at least 3 cm. above the end of the stump.

The operation is performed as follows:

From a point 8 cm. above the line where the tibia is to be divided, make a longitudinal incision through skin and superficial fascia 3 cm. behind and parallel with the fibula. The incision is curved forwards above the head of the fibula.

Place clips on the edges of the superficial fascia.

Divide the peroneal nerve behind the head of the fibula, expose it upwards,

reflect its divided end and push it upwards behind the biceps tendon. Divide the tendon of the biceps and the collateral fibular ligament as close to the fibula as possible without injuring its periosteum. Open the tibio-fibular joint and free the head of the fibula, which is removed after division of the neck of the bone. Do not injure the insertion of the biceps tendon into the external tuberosity of the tibia.

To prevent injury of the anterior tibial artery and vein expose them at their passage under the fibula.

Separate the interosseous membrane from the shaft of the fibula. Be careful neither to injure its periosteum nor the main vessels.

Divide the fibula at the lower end of the incision.

From the inner and front side of the leg make a flap consisting of skin and superficial fascia. The flap must at least be 5 cm. longer than the diameter of the leg at the point chosen for the division of the tibia.

At the same level join the upper ends of the flap incision by a horizontal incision around the outer and posterior part of the leg.

Divide the fibula 2 to 3 cm. above the last incision. Treat both ends of the left piece of the fibula according to Hirsch-Bunge.

Divide the muscles at the line chosen for the section of the tibia.

Divide the tibia and remove its periosteum and marrow for 1.5 to 2 cm. upwards. With the standing patient the sawn surface of the tibia must form accurately an horizontal plane. Its edges should be rounded with a file. Every point of the end of the tibial stump must bear and bear equally much. Carefully close the incision of the superficial fascia by a separate catgut suture.

Only when the leg stump has a length of at least 15 cm. there can become a question of leaving a piece of the fibula.

In case of reamputation the fibula is removed in the way above described. If the stump is non-end-bearing, a part of the tibia sufficiently large for treatment according to Hirsch-Bunge is amputated. If the stump is covered with healthy and movable skin and superficial fascia, these should be separated from the bone, but otherwise left as they are. Has the end of the stump a tender and immovable scar, an amputation sufficient for the covering of the stump with superficial fascia and normal skin is necessary.

CASE I.—W. O. S., aged thirty-seven years, male. Compound fracture of the leg, September, 1913. Primary amputation. Reamputation February, 1915. Correcting operation, October, 1915.

January 16, 1916: The stump, 24 cm. long, has open ulcers at the end and skin excoriations over the neck and head of the fibula. Chronic osteomyelitis of the tibia. Patient unable to work.

January 17, 1916: *Disarticulation of the fibula, reamputation of the tibia.*

November 1, 1919: Wears the artificial limb, which he had at the discharge from the hospital in 1916; has not later been in Christiania, but writes that he has been able to do all his work and that he is relieved of the former discomfort.

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CASE II.—O. H., turner, aged forty-two years, deaf and blind. Compound fracture of the leg several years ago. Primary amputation. Great tenderness and often ulcers over the fibula. Both walking and standing connected with discomfort.

May 16, 1917: The stump, 25 cm. long, non-end-bearing; skin over the neck of the fibula red and ulcerating.

May 17, 1917: *Disarticulation of the fibula, reamputation of the tibia.* Hirsch-Bunge method.

November 1, 1919: Has since the removal of the fibula become quite a new man. He walks like a healthy man and can walk and work the whole day without discomfort.

CASE III.—I. A. A., waiter, aged fifty years. Compound fracture of the leg, June, 1915. Primary amputation. Reamputation October, 1915, and February 1916.

May 29, 1917: Stump 10 cm. long, tender over the head of the fibula.

May 30, 1917: *Disarticulation of the fibula and reamputation of the tibia.*

November 1, 1919: Good end-bearing stump, its skin healthy and not tender. Patient is neurasthenic, mentally depressed and unequal to resume any occupation, but his former condition is considerably improved.

CASE IV.—B. P., aged forty-four years, typographer's wife. Amputation of the leg on account of phlegmonous inflammation in 1914.

June 18, 1917: The stump, 17 cm. long, very tender over the head of the fibula, non-end-bearing. The exceedingly stout woman can walk only with difficulty and much pain.

June 27, 1919: By local anæsthesia *disarticulation of the fibula and reamputation of the tibia*, a tender scar under the end of the stump removed.

November 1, 1919: During the first three months patient says that walking was a pleasure. Later she has been much troubled by ulcerations of the skin at the end of the stump.

CASE V.—F. N., aged twenty-three years, female student. Poliomyelitis sixteen months old; operated for tuberculosis of the tarsus in her tenth year. 1912, arthrodesis talocalcanea. Reoperation 1914.

June 10, 1917: All the joints of the foot stiff. The walking painful and greatly limping.

June 11, 1917: *Amputation of the leg and disarticulation of the fibula.*

September 1, 1919: By much walking the skin of the stump is liable to soreness. The walking is owing to muscular insufficiency since the poliomyelitis not perfect but greatly improved.

CASE VI.—L. S., aged twenty-five years, farm laborer's wife. Tuberculosis of the ankle-joint.

September 5, 1917: *Amputation of the leg and disarticulation of the fibula.*

November 1, 1919: The stump, 22 cm. long, end-bearing. Patient walks nearly normally and practically without a limp.

CASE VII.—T. H., artilleryman, aged twenty-six years.

July, 1914: Compound fracture of the leg. Primary amputation.

Stump often painful. During the last year patient has been unequal to work and has rarely worn his artificial limb.

January 29, 1918: *Reamputation of the leg. Disarticulation of the fibula.* A 5 cm. long piece of the lower end of the fibula was left. No lesion or ligature of the larger vessels.

January 10, 1919: Since the last operation patient has constantly been at his work. He has partly worn his old, slightly altered, artificial limb with a thigh and leg bucket, partly walked with a free knee-joint. He walks like a healthy military man without the slightest limp.

CASE VIII.—O. S., aged forty years, laborer.

February, 1915: Primary amputation of the leg after compound fracture. The whole stump has always been tender and patient often disqualified for work and walking.

September 9, 1918: *Disarticulation of the fibula and reamputation of the tibia.*

November 1, 1918: The stump, 24 cm. long, end-bearing, with healthy skin. Patient declares the result of the last operation to be perfect and far better than anticipated. He is now fit for work.

CASE IX.—N. K., aged fifty-two years; unmarried country woman. Amputation of the leg for tuberculosis of the ankle-joint in 1899.

September 30, 1918: Stump very tender, great tenderness also over the upper end of the fibula.

October 1, 1918: *Reamputation of the leg. Disarticulation of the fibula.* Catgut ligature on the tibial vessels. The skin of the lower part of the stump has been liable to ulceration. Nevertheless the patient walks much better than before the operation.

CASE X.—K. G., aged fifty-nine years, sailor.

May, 1918: In New York, Pirogoff's amputation for compound fracture of the foot.

September 10, 1918: Great tenderness in the line between the tibia and os calcis. Patient cannot walk and wishes to be reoperated.

September 17, 1918: *Amputation of the leg and disarticulation of the fibula.* Catgut ligature on the tibial vessels. Superficial necrosis of edges of the amputation wound.

October 15, 1919: Stump 19 cm. long. Ulcers at the end of the stump have, until the three last months, again and again broken up. Patient has lately had an artificial limb with thigh and leg fitting and walks very well.

CASE XI.—P. G., aged twenty-one years, farm laborer. Tuberculosis of the ankle-joint.

March 12, 1919: *Amputation of the leg and disarticulation of the fibula.* Stump 20 cm. long.

November 1, 1919: Had prothesis three months ago. Walks very well and without pain and discomfort.

CASE XII.—A. S., mechanic, aged forty-two years.

1899: Amputation of the leg on account of compound fracture. The stump has always been tender and patient has often been disqualified for work.

April 28, 1919: *Reamputation of the tibia and disarticulation of the*

AMPUTATION OF THE LEG

fibula. The stump, 22 cm. long. A 5 cm. long piece of the fibula left near the lower end.

November 1, 1919: The last operation has given great satisfaction. Patient wears his old artificial limb only slightly altered; can walk all day and without pain and discomfort. He does all ordinary work.

CASE XIII.—B. F., aged seventeen years, female.

1913: Pirogoff's amputation on account of compound fracture of tarsal and metatarsal bones. The stump has always been painful and patient never able to walk more than about half an hour at a time. Wishes to be reoperated.

March 29, 1919: *Reamputation of the leg and disarticulation of the fibula.*

November 10, 1919: Patient wears her old prothesis, which finds good support under both tuberosities of the tibia. She walks well, without pain, and is highly satisfied with the operation.

CASE XIV.—M. K., aged thirty-four years, country shoemaker.

1901: Compound fracture of foot and leg by railway accident. Primary amputation.

September 23, 1919: The 27-cm. long stump has always been tender and patient has had much discomfort by walking. Soreness over the head of the fibula.

September 24, 1919: *Reamputation of the leg, disarticulation of the fibula.* A 5 cm. long piece from the lower part of the latter was left. No lesion nor ligature of larger vessels. Discharged October 18, 1919.

November 15, 1919: Patient still wears his old prothesis and walks without discomfort and considerably better than before the operation.

CASE XV.—S. A., aged twenty-four years, female. Gangrene of both feet from frost bite in 1917. On the right extremity a Symes, on the left a Chopart's amputation, was performed. Both stumps remained tender, and 1918 a Pirogoff's amputation took place on the left side, but with unsatisfactory result.

October 29, 1919: The patient came to me to undergo a bilateral amputation of the leg with removal of the fibula, an operation which was strongly recommended her by one of the aforementioned patients.

Status.—Across the end of the right stump runs a tender scar. Chronic osteomyelitis of the lower end of left stump.

November 1, 1919: *Reamputatio cruris dextri et disarticulatio fibulae.*

November 20, 1919: *Reamputatio cruris sin. et disarticulatio fibulae.* Right stump is 22 cm. long and end-bearing, the left 19 cm. long, but moderate tenderness of the end.

February 15, 1920: The patient walks still with a provisional appliance.

CASE XVI.—K. F., aged forty-three years, forest laborer. For two years suffering from tuberculosis of tarsal joints. As a result of the view of the artificial limb-maker *amputation of the leg with disarticulation of the fibula* was recommended, and the operation performed November 26, 1919, by Doctor Giertsen.

December 22: The stump is 26 cm. long and end-bearing.

February 15, 1920: Patient wears still a provisional fitting.

O. BORCHGREVINK

CASE XVII.—O. M., aged sixty-seven years, clergyman. Tuberculosis of the left ankle-joint of two years' duration; during last three months fistulous.

January 24, 1920: *Amputation of the leg with disarticulation of the fibula.*

February 15, 1920: The stump is 23 cm. long and end-bearing. The patient has not yet begun to walk.

ACCIDENTS AND PRECAUTIONS IN LIGATION OF THE COMMON CAROTID ARTERY

REPORT OF A FATAL HEMIPLEGIA

BY JOHN HOMANS, M.D.
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NOTHING can be more distressing to a surgeon than an operative fatality, more especially when investigation after the event reveals that he has failed to master the available operative indications and safeguards. The investigation, however, may be of advantage to others if it brings to light unfamiliar basic principles of pathology and treatment. In this way, a fatal outcome of common carotid ligation calls attention to a subject which surgical teaching has never made sufficiently well known.

Statistical studies in the literature show clearly that as an operation of election, ligation of the common carotid, even in fairly advanced age, is reasonably safe but that emergency operations are very dangerous indeed. In either case, the cutting off of the arterial circulation from one side of the brain, whether or not the sole cause of the fatality, offers itself as the complication principally to be dreaded. And since a collateral circulation has apparently been provided for by nature, arterial anomalies are most reasonably blamed for the failure of this mechanism. I have been unable to find, however, in the literature any instance of death immediately following carotid ligation in which there was a demonstrable anomaly of the circle of Willis, and since anomalies in the cerebral circulation are, I believe, commonly supposed by surgeons, and generally stated in the text-books, to constitute an unavoidable danger and to be the principal cause of death under these circumstances, it has seemed to me particularly worth while to dwell on this point, especially in consideration of the findings in the case here reported.

CASE I.—A. D., aged twenty-four years. The patient was brought to the Peter Bent Brigham Hospital at about 2.30 P.M. with the statement that he had been shot in the neck with a small-calibre revolver about an hour before. There was no story of any noteworthy bleeding. He lay quietly in bed without any noticeable difficulty of breathing and was able to speak in a low voice without evident discomfort. He swallowed fluids with a grimace. The pupils were equal and reacted normally. His color was pale, but with no evidence of exsanguination. The pulse was of good quality, the rate about 100; respirations, 25; temperature, 97.6°. There was a bullet wound in the middle line of the neck, a little below the level of the thyroid cartilage. There was swelling of the right side of the neck, the upper limit of which was about one-third of the way from the angle of the jaw to the sternum. This swelling was most pronounced about one-half way from the corner of the jaw

to the sternum and was moderately tense. It extended laterally a little beyond the external border of the sterno-mastoid muscle. It was separated indefinitely below from a second swelling, a little above the clavicle and slightly outside of the principal swelling. It extended beyond the middle line toward the left as if there were extravasation of blood under the deep fascia of the neck. There was no bruit, no pulsation and no thrill. A little bloody serum oozed slowly from the wound.

Stereoscopic plates showed that the trachea was pushed to the left from one-half an inch to an inch, beginning above the level of the sternum. The bullet was about one-half inch beneath the skin, two inches above the mid-clavicle on the right, and at the upper portion of the secondary swelling noted above the clavicle. No effort was made to follow the bullet track.

NOTE (quoted from the record).—"It seems probable from the position of the bullet, and from the position of the wound of entrance, that the bullet track must have passed close to the carotid sheath, if not through it, but it does not appear that the common carotid artery can be involved, since the swelling is not markedly tense or pulsating, as would be the case were there a free opening in the common carotid. Possibly the jugular vein is wounded, or possibly the injury may be to a thyroid vessel or to some artery outside the carotid sheath. There is evidently no extravasation of blood into the mediastinum.

"*Diagnosis.*—Gunshot wound of neck with injury to blood-vessel (unidentified)."

The patient was given morphia hypodermically in two doses of 10 mgms. each before being taken to the operating room.

Operative Note (September 19, 1919).—Ligation of common carotid artery—right. Exploration of bullet track and removal of bullet for gunshot wound of neck. Novocaine—chloroform. (Operation begun at 3.50 P.M.)

An incision was made transversely, excising the wound of entrance under novocaine infiltration, the incision being carried well outside the right sterno-mastoid in the direction of the folds of the neck. The central end of the incision must have been about an inch below the thyroid cartilage. The platysma and skin were dissected upwards and downwards for several inches, giving access to the region of the bullet track. Incision was then made along the inner edge of the sterno-mastoid muscle and the muscle was dissected up and lifted outwards with retractors. The inner and posterior surfaces of the muscle were widely infiltrated with blood. At this point the patient complained so bitterly of the exploration in spite of the infiltration with novocaine that he was given chloroform, lightly, by the drop method. The sterno-thyroid and sternohyoid muscles were now rapidly divided with the knife, while with the finger the remains of the sinus tract down to the carotid sheath was torn through, causing a heavy gush of arterial blood, apparently from the common carotid.¹ After the bleeding had tem-

¹ The gush of blood, though heavy, had not the violence ordinarily observed in the severance of a large vessel—an indication that the blood pressure was comparatively low.

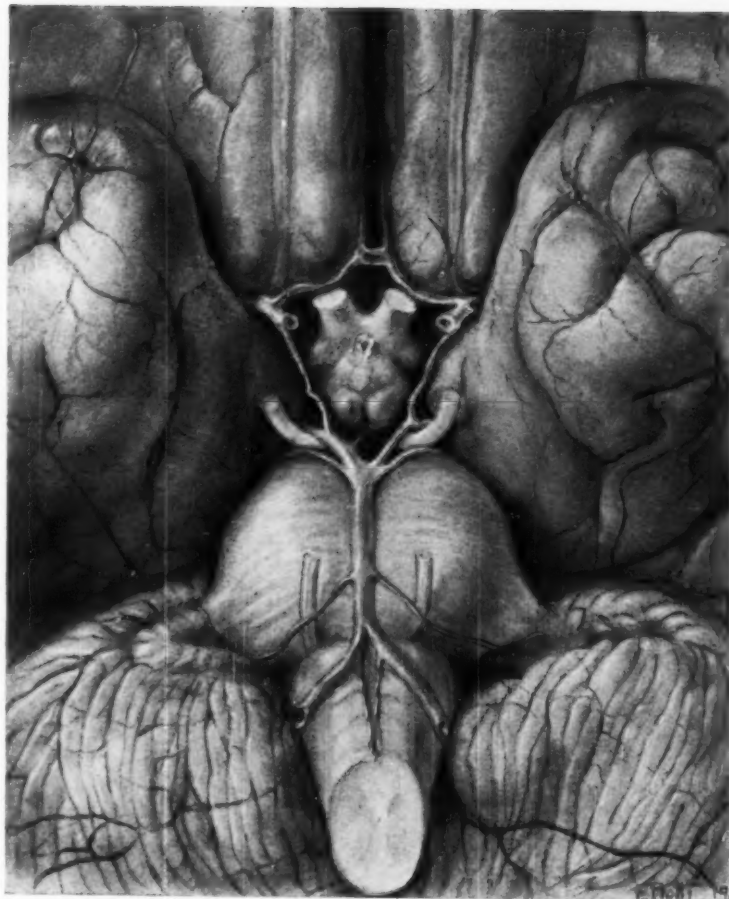
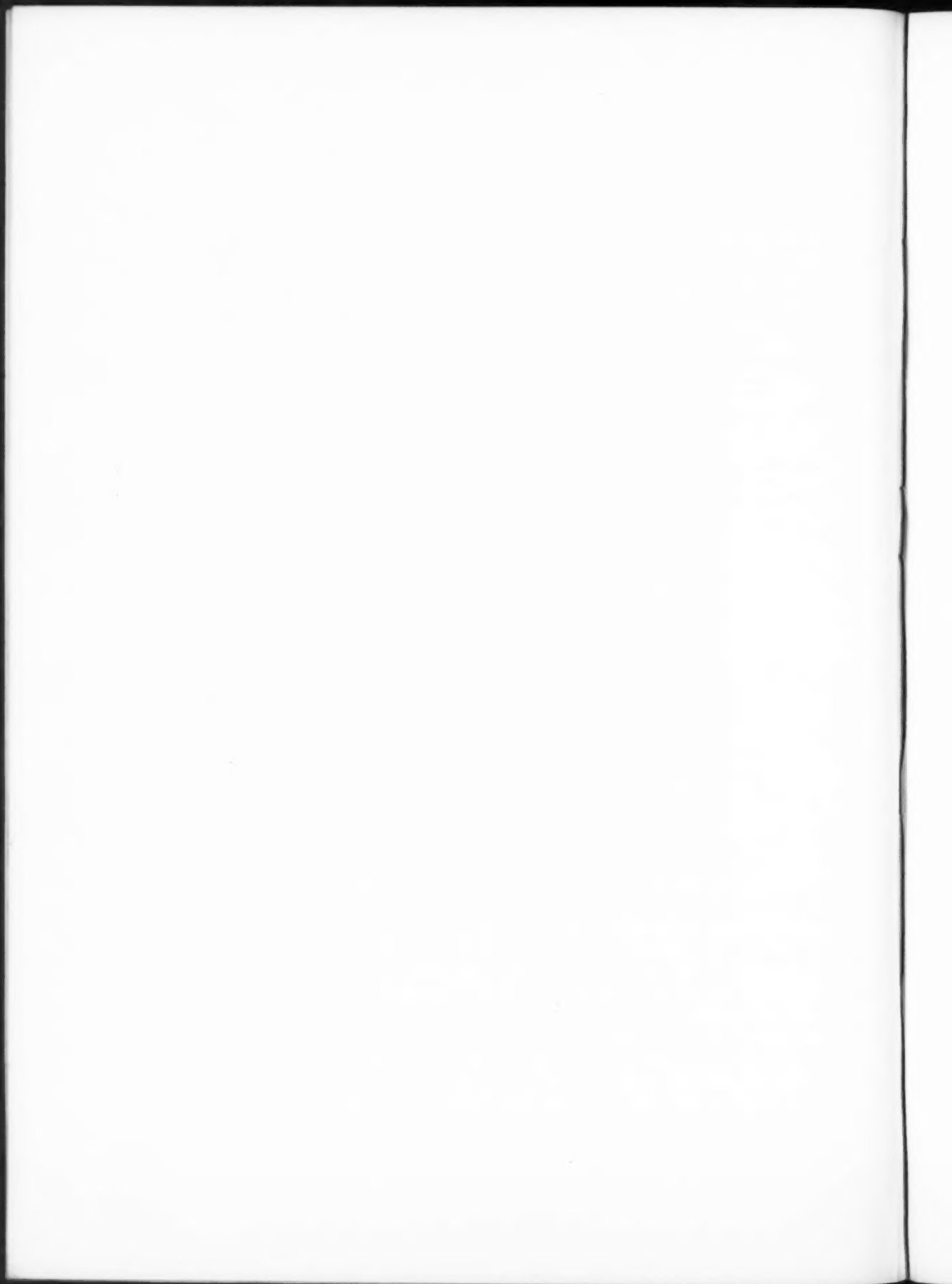


FIG. 1.—Base of the brain showing the arteries constituting the circle of Willis. The anterior communicating artery appears double but the posterior portion alone is patent and is considerably smaller than usual. All vessels are slightly smaller than vessels of control specimens. No gross anomaly.



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porarily been stopped by clamping at the point where the finger felt the gush, an attempt was made to follow the carotid sheath upwards and downwards, but in drawing away the infiltrated tissues below the point where the clamp had been applied, the gush again started, showing that the clamp had merely closed soft tissues over the opening in the artery. Pressure upon the bleeding point again stopped the bleeding but now caused intense cyanosis and difficulty of respiration, as if the vocal cords were paralyzed. Intraparalaryeal insufflation by means of a nasal tube was therefore instituted. Since it seemed probable that pressure by the finger was in some obscure way the cause of the sudden upset, the artery was clamped and doubly ligated as rapidly as possible, but though inspection showed that the clamp had seized the common carotid artery alone and that no other structures appeared to be injured, the character of the patient's respiration continued the same. The pulse, however, which was always good, did not go above 120, and during the last of the operation fell to 108. There was at no time any marked change in its character. Though the amount of chloroform given was very small, the patient showed no tendency to return to consciousness afterwards. The left side of the body was completely paralyzed, including the face, and it appeared that the blood supply to the right side of the brain was completely gone. While on the table the patient showed peculiar, almost rhythmic, contractions of his right hand.

Postoperative Notes (September 19, 1919. Eight P.M.).—Aside from improvement in color and slowing of the pulse to about 100, there is no marked change. The patient moves his right arm, leg and face in response to stimulation, but no movements, voluntary or involuntary, are made on the left where there is a flaccid paralysis. There is a very slight plantar response to stimulation of the sole of the foot on the left, but this has only been obtained once.

September 20, 1919, 8.30 A.M.: During the night the patient has gradually returned to consciousness and now speaks with great effort and considerable hoarseness, his words being jerked out between rapid respirations. He moves the right side of the body intelligently and can hold a glass of water from which he drinks through a tube, but swallows with such difficulty that this procedure appears very dangerous. He is very restless, continually moving the right leg and arm with a jerky motion. His temperature has gradually risen to 102.5° , his pulse to about 160, and is of very poor quality. He is very pale, slightly cyanotic, and breathes violently and rapidly with the use of his accessory muscles. This type of breathing appears to be due to some central cause. The *left* side of the face contracts, especially about the nose and *left* side of the mouth, but the rest of the left side of the body remains flaccid. At about 9.20 he was given about 50 c.c. of water through nasal tube passed to the lower end of the œsophagus. This procedure caused a little coughing but no choking and accordingly about 200 c.c. of hot chicken broth were given. At this time the respirations were so labored and the patient was evidently using himself up so fast that it was decided to give 10 mgms. of morphia. This was

done at about 9.35. Within a few minutes of this time, probably before the morphia could have had any effect, the patient seemed to have increased laryngeal obstruction, turned rapidly cyanotic, and within a minute his respirations had practically ceased. A rapid tracheotomy and artificial respiration were unavailing.

The autopsy was made by the medical examiner, who, unfortunately for this investigation, was no more familiar than myself with the possible causes of fatality following carotid ligation other than the supposed anomalies of the circle of Willis. The wound in the neck was carefully explored and it was found that the common carotid artery had been tied one to two inches below the bifurcation. Careful examination showed that there was no injury to any of the neighboring structures. The bullet had passed behind the jugular vein without wounding it, and although there was a blood clot adherent to the sheath of the vagus, the nerve itself was not injured. On removing the ligature, it was found that the bullet had passed cleanly through the artery, leaving its walls intact between the wounds of entrance and exit. A wide hemorrhagic infiltration extended well into the mediastinum, but not in sufficient quantity to have caused any pressure symptoms. No dissection was made of the left side of the neck, which, as it will be subsequently shown, was a most unfortunate omission.

The brain, *in situ*, appeared normal. No asymmetry in color or vascularity between the two hemispheres could be determined. The appearance of the base was equally negative. The internal carotid arteries were free from thrombi and of equal size. At first sight the circle of Willis, the basilar artery, and the vertebrals presented nothing out of the common. The only abnormality which could be found was what appeared to be a double anterior communicating vessel of rather irregular calibre. The remainder of the autopsy was unimportant: the blood-vessels were soft; there was no concomitant disease. The brain was hardened by immersion in formalin.

Subsequent examination and comparison with a number of other formalin-hardened brains disclosed that the first impression obtained at autopsy was not quite correct. The double anterior communicating vessel proved to consist of a single small artery and a parallel fibrous band. The circle of Willis was, in other respects, within normal limits; that is, the posterior communicating arteries were of about average size.² The really important difference between this and the control

² Windle in 200 examinations of the circle of Willis records the following: Seventy-six cases absolutely normal; 119 approximately normal (43 show disproportion between right and left posterior communicating). As the various constituents of the circle of Willis:

Anterior cerebrals: 181 normal; union of anterior cerebrals, 6.

Anterior communicating: 159 normal; duplicity in 14; incomplete duplicity, 6; absent (by union of anterior cerebrals), 6.

Posterior cerebrals: 173 normal. Posterior cerebrals arise from internal carotid instead of basilar; on the right, 11; on the left, 9; on both sides, 4.

Posterior communicating: Absent on right, 9; on left, 13; on both sides, 3; disparity in size, 43 (as above); very small vessels, 7; where one side is better supplied, the right is favored.

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brains lay in the comparatively small size of the two internal carotids, the vertebrals, the posterior cerebrals and the basilar. That these vessels presented no arterial disease, there is no doubt, but that in their formalin-hardened condition they presented a true picture of their appearance in life is less certain. They may well have undergone contraction following operation and have been so preserved by the fixative. Or they may conceivably have shrunk in fixation. In any case there is no *proof* of an abnormality outside of the very small anterior communicating artery. Accurate comparative measurements of many fresh specimens would have been necessary to determine whether the basal vessels were actually outside normal limits. One can only say that they appeared small. Serial section of the brain failed to reveal the slightest difference between the right and left sides. In view of the method of fixation (immersion) microscopic study was not undertaken. (The accompanying drawing was made from the preserved specimen.)

Comment.—Before proceeding to a discussion of the subject of cerebral deaths following carotid ligation, comment is pertinent that no careful study of the patient's blood-pressure was undertaken before operation and no observations were made as to the character of the vessels or the volume of their pulsations above the injury. It should also be noted that chloroform, though in small quantity, was used as an anæsthetic; that the patient's cerebral symptoms came on at the moment at which the right common carotid was occluded by pressure of the finger, and continued, following the application of ligatures to the artery alone, after this pressure was removed. There is no reason to believe that any local nerve injury existed prior to operation or was caused by operation. There is a suggestion that the respiratory changes consequent upon ligation were of central rather than peripheral origin—a suggestion which is made more definite by the discovery later that there was a paralysis of deglutition. Finally, the failure carefully to study out at autopsy the arterial relations of the terminal branches of the external carotids on both sides must be kept in mind.

The Literature of the Subject.—Although carotid injuries have long been the subject of consideration, and even of animal experimentation, little of the literature previous to the antiseptic and aseptic periods is of other than historic value, since many apparent effects of these injuries can, in all probability, be ascribed to sepsis and to associated damage to adjacent structures. Even studies during recent times in respect to the part played by cerebral complications are not always easy to interpret. The following summaries of the investigations of a number of writers are representative of the whole subject.

Siegrist, in 1900, collected several hundred instances of carotid ligation performed for various purposes. Many of these evidently go back beyond the aseptic, and perhaps antiseptic, period. He finds, among 113 ligations performed for pulsating exophthalmus, 10 deaths, a mortality of 8.8 per cent.; among 41 ligations for nerve lesions and elephantiasis of the face,

1 death, a mortality of 2.4 per cent.; among 177 ligations performed during operations upon tumors, 50 deaths, a mortality of 28.3 per cent.

Siegrist contrasts these figures with those of carotid ligations performed for hemorrhage. Among 322 such operations, there were 163 deaths, a mortality of 50.8 per cent. He analyzes this mortality by decades to show that from ten to forty years it is, respectively, 35.7 per cent., 38.4 per cent., and 37.5 per cent., or about the same for each. But below ten years it is only 14 per cent., as opposed to 92 per cent. in individuals between sixty and seventy.

In general, Siegrist is inclined to minimize the importance of the circle of Willis in carotid ligation and to lay the cause of death to conditions outside of the cerebral circulation itself. He is able to find very few instances (16 out of 371 fatal ligations) in which the circulatory changes consequent upon carotid ligation can *alone* be blamed for the death.

Sir George Makins, in a recent publication upon the subject of gunshot injuries of the blood-vessels, considers at length wounds of the common carotid and its branches. In a discussion of cerebral complications he points out that in carotid ligation, as in the interruption of the arterial supply to a limb, the effect of hemorrhage through reduction of the general blood volume must be of great importance. Equally so, sepsis. But the effect of individual idiosyncrasies in the cerebral circulation, the size of the bony foramina and the variations in the circle of Willis are factors about which no positive evidence is obtainable. Makins raises the question whether local occlusion of the principal blood supply is alone responsible for extreme cerebral anæmia; whether, in fact, there is not superadded a vascular spasm which augments and continues the anæmia by preventing an influx of blood to that part of the brain rendered bloodless by the sudden carotid occlusion. If this were so, lowering of the general blood-pressure would be of primary importance; variations in the local anastomotic circulation a secondary factor. A muscular closure of cerebral arteries would naturally occur following the sudden interruption of their main blood supply, a closure which a lowered blood-pressure would be powerless to overcome. "Vascular stupor," such as has been described by Veau in the case of the extremities, might equally close the peripheral distribution of the carotid artery. Such effects Makins feels could best be combated by transfusion, a means of raising the blood-pressure which, as far as he knows, has not been adopted.

Makins believes that in ligating the arterial supply to any part, the vein as well should be divided, giving sound reasons for this statement. He speaks of the use of the Tuffier tube to tide over the occlusion of a vessel, and in general, prefers the repair rather than the ligation of large arteries, provided this can be done with a good prospect of success.

Among Makins' list of carotid injuries is a group of 14 instances of ligation for secondary hemorrhage. Of these, hemiplegia developed in 3 (21.4 per cent.). In only one of those three could the immediate fatality

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be attributed to the cerebral lesion. Another resulted in permanent hemiplegia and aphasia, while the third improved.

In another group of 13 cases in which early operation was undertaken for arterial or arteriovenous hæmatoma, the 5 hemiplegias (38.4 per cent.) resulted in 2 deaths, of which one occurred within twenty-four hours, while the second could not be attributed to the cerebral damage.

In another group of 15 cases of minor carotid injuries, a considerable number of thromboses caused permanent disablement of one side of the brain, but Makins properly points out that this group may not give a correct idea of the incidence of thrombosis, since the number of cases of this sort which never present themselves for treatment is unknown.

To show the comparative harmlessness of operations for late traumatic aneurisms of the carotid, Makins presents a series of 10 purely arterial aneurisms operated upon without hemiplegia or fatality.

A final analysis of the 85 injuries to the common carotid gives a total mortality of 13 (or 15.2 per cent.). Of the 13 fatal cases, 3 deaths were due to concurrent injuries to other parts, 3 to secondary hemorrhage, 1 occurred during chloroform anæsthesia, and 6 (or nearly one-half the 13—roughly, 7 per cent. of the total number) died in consequence of cerebral complications.

Makins points out that the majority of fatal cerebral accidents occur in the early operations for hemorrhage and for hæmatoma. His views seem to me so sound on the subject of the general policy to be pursued in the treatment of common carotid injuries seen at an early stage that I quote from him in full (page 164):

"In view, however, of the grave consequences which may ensue in the event of recurrent or early secondary hemorrhage occurring, very special care must be taken not to overlook an arterial injury, and in the case of a hæmatoma developing when the apertures of entry or exit of the soft parts are of considerable size, temporary cessation of bleeding should not be regarded as sufficient justification for taking up an expectant attitude. The risks are particularly great should any doubt exist as to the practicability of maintaining the wound in an aseptic condition. When the wounds of the soft parts are of the minimal type, whether they are through-and-through tracks or the foreign body is retained, if hemorrhage has ceased, an expectant attitude is preferable, especially if a considerable amount of blood has been lost, if symptoms of shock are present, or if the conditions under which the operation has to be undertaken are not entirely satisfactory. In any of these circumstances the risk of delay in active intervention is far less than that attendant on sudden occlusion of the carotid vessels at a time when the general blood-pressure is probably low."

Finally, Makins summarizes the indications for operative intervention in case an expectant attitude has been taken. (1) Secondary hemorrhage either from the external wound or from the mouth. (2) Extension of the hæmatoma. (3) Development of pressure signs such as dyspnœa or dysphagia.

(4) For the cure of the resulting traumatic aneurism. In all operations, until the exact location of the injury is known, ligation of the common carotid should be temporary.

Shaw, in an article devoted to ligation of the common carotid artery, states that in thirty months in a casualty clearing station, among a total of 44,000 wounded, he had only seen three cases in which ligation of the common carotid appeared to be indicated. These were: one for secondary hemorrhage, another for superficial aneurism, and the third for an extension of hæmatoma in spite of rest in bed. In one of these cases, ligation caused complete aphasia and hemiplegia, which ultimately recovered, the second caused no ill effects, the third ended fatally without cerebral symptoms.

DeFourmestreaux calls attention to historical instances of carotid ligation accompanied by hemiplegia, notably a case described by Ambroise Paré. His own conclusions are based upon cases collected during the six years previous to 1906. He speaks of the doubtful evidence of statistics, since it is not easy to show that ligation alone is responsible for accidents and fatalities. He calls attention to the figures showing the low incidence of accident in common carotid ligation for pulsating exophthalmus and for aneurism. In contrast, he finds a mortality of six among eleven cases in which ligation was done for hemorrhage. Taking together the figures of many *earlier* investigators, DeFourmestreaux makes up the following table:

Ligature for hemorrhage, mortality	54 per cent.
Ligature for tumors, mortality	46 per cent.
Ligature for aneurism, mortality	13.5 per cent.
Ligature for pulsating exophthalmus, mortality	7 per cent.

In his study of cerebral accidents he quotes Lejars as follows: "At the moment when the ligature of the left carotid was completed, as the ligature was tightened, the respiration changed in character, stertor appeared, the patient became comatose, and died during the day."³ He quotes Quénu, who noted immediately after carotid ligation, in a patient considerably exsanguinated by a wound of the neck, paralysis with coma. These accidents he finds have been very rare, for as a usual thing hemiplegia appears two or more days after ligation (progressive thrombosis?). In such cases the arm is usually the first part affected and most completely paralyzed. In his anatomical study he reviews the cerebral circulation and speaks of the free communication between the terminals of the external and internal carotids, especially among the branches of the ophthalmic arteries. He finds considerable variation in the circle of Willis compatible with normal cerebral circulation. In ligation of the common carotid of one side, the brain may be supplied by the circle of Willis from the opposite side and by the external carotid of the opposite side.

DeFourmestreaux's theory of the immediate accidents holds that anatomical controls have been rare, and that while such controls might show circu-

³ An experience strikingly similar to that of the writer.

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latory anomalies, he does not believe that these tell the whole story. He holds deficiencies of the cardiovascular system, in general, and low blood-pressure, in particular, to be principally responsible. Late hemiplegias he attributes to thrombosis. He concludes that ligation of the common carotid does not constitute in itself a very dangerous proceeding. Prognosis is in accordance with the lesions for which the ligation is performed.

In studies of statistics, whether in civil or war surgery, the work of Crile on the "Effect of Temporary Closure of the Carotid Arteries" is pertinent. After preliminary experiments upon dogs, Crile temporarily occluded *both* carotids in a number of individuals operated on for tumors of the mouth and neck. He reports eleven cases in which both carotids were temporarily occluded without any accidents whatever. Among his patients, the oldest was fifty-eight and several were in the forties. The only disturbing symptoms were due to handling of the vagus nerve, which was readily controlled.

The subject is taken up very thoroughly in Sencert's chapter in "Medical and Surgical Therapy," edited by Sir Alfred Keogh. Here, as in Makins' book, will be found an excellent description of wounds involving the common carotid and its branches, of the diagnosis, indications for treatment, and the method of approaching the artery under various conditions. Sencert holds that primary operation is the sole means of guarding against infection, sudden increase in the size of the hæmatoma and against cerebral embolism. He believes that operation is easiest and least dangerous if done early because the subsequent matting together of adjacent structures, when immediate operation is not performed, makes a late operation more difficult. He believes that the argument in favor of delay based on the establishment of collateral circulation is, in general, fallacious, because the artery has probably ceased to convey any blood at the time operation is contemplated. Thus, if cerebral complications have not already occurred, ligation will not produce them. Moreover, early operation obliterates a much more limited vascular segment than a late one in which a wider dissection and ligation is necessitated by the extent and adhesion of the aneurismal sac. He recognizes the possibility, however, of immediate cerebral complications consequent upon ligation of a functioning vessel. This, he says, is rare, and he subscribes to the view that such accidents do not occur when normal anastomotic connections are intact, more especially that between the right and left carotid regions. He feels that in young subjects these complications are exceptional.

Finally, Guinard, after a large experience with aneurism, emphasizes the importance of the communications between the right and left external carotid systems. After ligation of one common carotid for aneurism he finds that if the branches of the opposite external carotid have a normal pulsation, circulation is restored through them to the internal carotid of the operated side. If, however, the opposite external carotid is functionless, ligation of the common carotid is likely to cause a fatal hemiplegia.

Summary of the Views in the Literature.—It is generally agreed that

carotid ligation done deliberately upon individuals in reasonable health has a low mortality. Wherever the mortality figures have been analyzed the contributory share of cerebral complications has been strikingly reduced, so that it appears to be a fair statement that in the absence of a wound, or of debilitating disease, ligation of one common carotid has an almost negligible risk of cerebral damage. Moreover, this risk is not necessarily very much greater with advancing years.

It further appears that ligations done hurriedly for wounds, or in the course of operations for tumors of the neck and jaws, have a high mortality and a very considerable incidence of cerebral complications. Sencert introduces a strong argument in favor of early operation upon carotid injuries on the ground that delayed operation increases the damage to adjacent structures and renders operation upon the resulting false aneurism infinitely more difficult. He regards cerebral accidents in early operations of this character as rare and for the most part unavoidable. Makins holds that, since the mortality of immediate ligation as opposed to that of operation upon the resulting aneurism is so high, early operation should not be performed unless the condition of the patient and the circumstances surrounding the operation are so favorable as to reduce the danger of a cerebral complications to a minimum.

All investigators lay stress on the vastly increased frequency of fatal cerebral disturbances in ligations of necessity as opposed to those of election. This increased incidence of cerebral complications when the general circulation is deficient is perhaps enough to belittle the rôle of circulatory anomalies at the base of the brain, and to enhance the importance of the blood-pressure in restoring the circulation in vessels suddenly emptied and perhaps thrown into a state of spasm by occlusion of their principal sources. There are reported in the literature a very considerable number of deaths directly resulting from cerebral complications of carotid ligation, and there is a very small class in which the death is strikingly like that of the case here reported, but I have not been able to find in the literature any fatality in which an arterial anomaly was held to be solely responsible.

The Application of the Findings of Others to This Fatal Case.—It seems to be true that in approaching a case of gunshot or other wound supposed to involve the common carotid, one should be able to make the diagnosis from the shape and appearance of the hæmatoma, which is usually described as in the subject of this report. It appears that examination of the peripheral arteries on the same and opposite side of the neck may or may not be of value, depending upon whether the vessels pulsate equally and whether they appear of normal and equal size and consistency. It may reasonably be held that, in view of this patient's quite normal condition before operation, all peripheral vessels could have been felt. Pulsation was absent after operation in the peripheral vessels on the side ligated, showing that they were getting no blood from those of the opposite side. If, however, it had been noted before operation that the peripheral vessels of the *opposite* side were

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small or pulsated feebly, it might have been expected that they would be incapable of furnishing a collateral circulation to those of the ligated side. The failure to make these observations constitutes an indictment of the procedure in this case.

Since it is generally held that a low blood-pressure renders carotid ligation particularly dangerous, it would have been important to have known the blood-pressure here. The patient, however, appeared so little shocked and there was so little tendency of the wound to bleed that no one thought of taking it. Had it been found to be low, there is no question that the operation should have been postponed or undertaken in a very different manner. My recollection, however, is that when the common carotid actually spurted for a moment before pressure was made upon it, the gush of blood, though fairly abundant, was not the powerful rush generally noted on opening a large vessel. It may, then, be true that the blood-pressure in this patient was lower than might have been expected.

Again, in approaching a common carotid injury it appears that one should always prepare for temporary ligation below the point of suspected injury. Even if it is not certain that there is a carotid wound, the incision should be so made as to lay bare the carotid below the point of possible damage. After it has been temporarily ligated or clamped, the subsequent exploration is much less likely to result in bleeding (though back bleeding from the external carotid may well take place), and in any case, temporary occlusion gives the operator a choice of subsequent repair or ligation. This procedure was not considered here since the importance of the damage was not fully understood. The operator should also be prepared to maintain temporarily the carotid circulation by means of a paraffined tube, as recommended by Tuffier. This procedure has proved to be of real importance in wounds of the popliteal artery, if only in an occasional case, and might have been of great assistance in this one. I can conceive that it might even have been carried out some minutes, if not hours, after the untoward effects of the ligation became apparent. Again, as pointed out by Makins, there is good ground for believing that transfusion of blood would have been of advantage before, or during, operation and might even have saved the patient after the cerebral accident had occurred.

Finally, since any general anæsthetic, and particularly chloroform, has a depressing effect upon the circulation of a patient in shock or near it, local anæsthesia is definitely indicated and should not be abandoned without good reason. Novocaine was, in fact, used here to begin with and was succeeded by chloroform, chosen for its non-irritating quality in view of possible damage to the air passages by the bullet.

There are, then, a number of indictments which can be made against such a procedure as was here employed, even in a young individual with a questionable carotid injury, not apparently in poor condition. The mere fact that the procedure was one that any trained surgeon might naturally use in his ignorance of the fine points in an operation very rare in civil prac-

tice, does not leave him without the responsibility for the fatal outcome. Hence the publication of this case with the comments which have been made.

SUMMARY AND CONCLUSIONS

It may be concluded that if an injury to the common carotid is suspected, the patient should be studied with a view to determining the quality of the emergency collateral circulation; that the operator should consider the strength of the arterial circulation as demonstrated by the blood-pressure and the apparent degree of shock, or its absence; that he should not undertake the procedure in the absence of signs of dangerous extension of the local hæmatoma and in the absence of external hemorrhage, unless all the circumstances appear favorable for the resumption of a collateral cerebral circulation; that he should be prepared for the temporary or permanent repair of the common carotid in case temporary occlusion induces immediate cerebral symptoms; that he should ligate the jugular vein before or during occlusion of the artery; that he should be prepared to give blood transfusion to the patient; that he should use an anæsthetic the least disturbing to the heart and to the brain—in other words, that local anæsthesia should be used wherever possible; and that in case immediate operation is for any reason delayed, he may properly expect a greater likelihood of injury to adjacent nerves, but a far lower incidence of cerebral complications.

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REPORT OF THE CONDITION OF A CASE OF COMPLETE
DIVISION OF THE SPINAL CORD BY GUNSHOT WOUND
NINETEEN YEARS AFTER THE INJURY

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THE case that I am about to describe is the same one reported by Dr. Francis T. Stewart and Dr. Richard H. Harte in the *Philadelphia Medical Journal* of June 7, 1902, under the title of "A Case of Severed Spinal Cord in Which Myelorrhaphy was Followed by Partial Return of Function." This report aroused much discussion at the time and the claim that function in the lower limbs had returned was received with considerable scepticism. In spite of the fact that this patient was examined repeatedly by different physicians, and was exhibited before many medical societies, no definite conclusion to substantiate this claim was ever reached.

Since 1902 our knowledge of the physiology of the spinal cord has been greatly augmented, not only through the monumental work of Sherrington, "The Integrative Action of the Nervous System," London, 1906) in the laboratory, but also through innumerable clinical investigations on man. This is particularly true of those made by Riddoch,¹ Head,² and others upon cases of complete division of the spinal cord from gunshot wounds observed during the recent war. It seemed most important, therefore, to record the present condition of Doctor Stewart's patient, it being nineteen years since the injury was inflicted. I know of no other case that has survived so long a time after complete division of the spinal cord. This report was originally planned to be made in conjunction with Doctor Stewart, but his recent sudden death prevents the carrying out of this plan. I can only add that he agreed with the views that are expressed here.

An abstract of the history, as given in 1902 by Doctor Stewart and Doctor Harte, is as follows:

C. N., twenty-six years old, was admitted to the Pennsylvania Hospital, in Philadelphia, January 21, 1901, having been shot in the back with a .32-caliber pistol. The bullet had entered one inch to the right of the seventh dorsal spine and had passed directly into the spinal canal. There was immediate and complete motor and sensory paralysis below the level of the tenth dorsal spine, and all the superficial and deep reflexes were abolished. Three hours after the injury an operation was performed by Doctor Stewart. The laminae of the seventh and eighth dorsal vertebrae were removed; the membranes were found to be lacerated, and the spinal cord was seen to be completely severed. There was a distance of three-fourths of an inch between the severed ends of the cord. This observation was confirmed

¹ Brain, 1917, xl, 264.

² Brain, 1917, xl, 188.

by Doctor Mitchell, Doctor Fraley and Doctor Newlin, who were present. The divided ends of the spinal cord were approximated with catgut sutures and the wound was closed. Surgical recovery was uneventful.

From a study of the history of this case it would seem evident that the patient must have been in a state of "spinal shock" on admission to the hospital, and that this had persisted for exactly three weeks, for further on in the report it is stated that the patellar tendon reflex was detected for the first time on the twenty-first day after the injury. Involuntary movements of the lower limb were noted on the thirty-fourth day. This must have marked the beginning of the establishment of the condition known as the "mass reflex," referred to below. From this time on the movements observed in the lower limbs could not have been voluntary, for at present it can easily be demonstrated that the patient is completely paralyzed in all portions of the body below the costal margins, and that the muscular contractions that were formerly regarded as voluntary movements are in reality the involuntary contractions recognized as the "reflexes of defense," or the "automatic" or "reflex" movements that, collectively, go to make up what Riddoch has termed the "mass reflex," which is so essentially characteristic of complete division of the spinal cord.

Examination in 1919-20.—There is complete paralysis of motion and sensation below the level of the tenth thoracic spine. The lower limbs feel rigid, but there is no wasting. The skin over the legs is somewhat waxy in appearance and pits slightly on pressure.

Involuntary flexor movements of the lower limbs occur at irregular intervals. When the patient sits quietly, the contractions may be absent for hours at a time, but on making the slightest movement or on cutaneous stimulation marked flexor spasms occur, and if stimulation is repeated rapidly, they become quite violent. There is extreme rigidity of the limbs, making it necessary for the examiner to use considerable force in extending the leg; after complete extension has been accomplished, however, the limb, as a rule, gradually resumes the partially flexed position. This is due to the predominance of the hypertonicity of the flexor muscles, but with the patient in the sitting position, it is also favored by gravity. When the patient lies prone upon the bed, the limbs can be extended fully by the examiner, and they will then remain in this position until some form of stimulation causes a reflex contraction of the flexor.

With the aid of braces arranged so as to extend up to and include part of the trunk, and with circular metal strips about the lower leg to prevent complete flexion of the limbs the patient is able to stand erect between two chairs, first by supporting herself with her arms and hands, then arranging her lower limbs in extensor spasm, favored by gravity, and next removing the support of her arms, and using them only to balance with. In this way she assumes the erect posture in a purely "reflex manner," but maintains it only momentarily. Tendon-reflexes cannot be elicited because of rigidity. There is a bilateral Babinski sign, but most of the time the great toe is held in dorsal flexion as a

COMPLETE DIVISION OF THE SPINAL CORD

fixed Babinski position. If the soles of the feet are strongly stimulated, an upward movement of all the toes, dorsiflexion of the foot, and strong flexion at the knee and hip take place.

On scratching the skin of the abdomen, no muscular response ensues.

Sensation.—Sensation is entirely abolished, although the patient does complain occasionally of a feeling of fulness and discomfort in the abdomen, which is generally worse after excessive movements of the limbs. Hallucinations as to the position of the toes or feet still exist and are very annoying.

Bladder.—The bladder is emptied automatically. With practice and judgment she is enabled to anticipate evacuations and to get along fairly well, but occasionally she soils herself and at times she wets the bed during sleep.

The patient's general health is good. She is most optimistic, and really believes that she has recovered voluntary motion. In making a sensory examination her answers are quite misleading. At times, when the skin of the leg is pricked with a pin she seems to answer correctly, although it is certain that she does not feel the slightest sensation below the level of the lesion. It is my belief that, as the result of repeated tests, she has learned to recognize the traction exerted upon sound muscles of the thorax above the level of the lesion caused by involuntary flexor spasms of the stimulated limb, if these were violent, and only then she very rarely answers that she feels the pin-prick. Moreover, in her anxiety to assist she unconsciously deceives the examiner, so that unless care is exercised, one might easily be misled into the belief that certain sensations still exist.

The transitory abdominal discomfort which she at times complains of, and which consists of a feeling of fulness and distress in the epigastrium and abdomen, together with nausea, can be explained on the assumption that the condition is the mechanical or reflex result of frequent flexor spasms of the lower limbs and of traction made on the abdominal muscles. The fact that the patient states that she cannot vomit is significant.

Treatment for the relief of these sensations should be directed toward diminishing the violence and frequency of the involuntary movements. This is done by ascertaining the most comfortable position for the paralyzed limbs and avoiding undue reflex stimuli. The patient has learned this as the result of experience, and fully appreciates its importance. She is generally cheerful and spends her time sitting fully dressed in a wheel chair and knitting sweaters, from which she derives a good income. She devotes a part of each day to going for short distances in her chair.

It must, nevertheless, be denied emphatically that any return of function has occurred; such a statement was purely the result of error in making the observations.

This case does, however, prove that complete division of the cord at the tenth thoracic segment by gunshot wound is not in itself necessarily fatal, for if automatic emptying of the bladder can be established, it is possible for the

WILLIAMS B. CADWALADER

patient to live a comfortable chair life indefinitely. Furthermore, it goes to prove that, even under the most favorable conditions for surgical procedure, return of function does not occur, for in this case the separated ends of the severed spinal cord were approximated by sutures within three hours after the injury, and after careful nursing for nineteen years no clinical sign of a return of function has appeared. It can, therefore, be assumed that regeneration of the spinal cord does not take place after complete section and end-to-end suture.

FISH-SCALE GALL-BLADDER *

BY JOHN RIPLEY CORKERY, M.D.
OF SPOKANE, WASH.

FOR some time in the surgical laboratory in St. Mary's Hospital, of Rochester, Minn., a condition of the gall-bladder has been recognized and diagnosed "Multiple Small Cysts of the Mucosa." Grossly, the mucosa appears to be studded more or less profusely with cyst-like bodies of 1 mm. more or less in diameter. These are nearly the color of normal mucosa. While carrying on some work on the investigation of the deposition of lipoid substance in strawberry gall-bladder, the writer received a fresh specimen, directly from the surgeon, which presented grossly the combined appearance of strawberry gall-bladder and multiple small cysts of the mucosa (Fig. 1). The picture strikingly resembled the scales of a fish (Fig. 2). On section to study the lipoid substance, it became apparent that in this case no cysts were present. Search of the museum records disclosed that there had been found, and diagnosed, 13 cases of multiple small cysts of the mucosa, in the last three years among a total of approximately 3000 gall-bladders removed in the Mayo Clinic in that time. These, together with 14 cases received directly from the surgeon, furnished the material for this study.

The study was made in the following manner:

I. Museum specimens. *a.* Gross study: Of the 13 cases eleven had gall-stones.

The specimens being already hardened in formaldehyde were worth little from the standpoint of gross inspection. The fact that only 13 cases had been found in three years and that 14 cases were found in six months is due to closer study.

b. Microscopic study: Blocks were cut from the most promising areas in each specimen and stained with Sudan 3 or Scarlet R and hæmatoxylin. No object is served in reporting separately the observations here made.

II. Fresh specimens. *a.* Gross inspection and photography. Each case was studied by history before operation, by inspection during the exploratory examination, by inspection right after operation, opened, and studied by inspection and observation under 52 mm. lens dissecting microscope under salt solution, photographed and blocks cut from the most promising areas and immediately placed in 10 per cent. formaldehyde. Stained sections were returned the next day while the case was fresh in mind, and the atmosphere was thus entirely different from the dry dust of the museum. The gross appearance of a normal gall-bladder is an open question, but the appearance of one nearly normal is familiar to most surgeons (Fig. 3).

The following observations were made:

* Read before the Stevens County Medical Society, March 31, 1920.

1. Gall-stones were present in eleven cases.
2. The history was always what came to be known as RCM in contrast to a GSA.
3. The longer on an average the history, the more pronounced the fish-scale appearance.
4. Recent exacerbations showed more deposition of lipid substance grossly.
5. In some cases the area of fish-scale appearance was small, while in other areas the mucosa might be more nearly normal or might be nearly destroyed. (Figs. 4, 5, 6.)
6. In some cases the whole mucosa was covered with the fish-scale appearance. (Figs. 2, 7, 8.)
7. Puncture of the cyst-like bodies under the 52 mm. lens never produced a spurt of liquid.
8. In some cases true papillomata were present. (Fig. 9.)
9. In some cases there was a condition that would be called papilloma, except no lipid substance was visible.
10. Two gall-bladders were found with fish-scale appearance and with a few cysts in another area which were identical in appearance with small subserous cysts of the peritoneum.
11. Some cases showed lipid substance on visual inspection, some only with the 52 mm. lens, and some not at all.

b. Microscopic study: The blocks cut as above were sectioned and stained with Sudan 3 or Scarlet R and hæmatoxylin. Study and photomicrography were carried on together. The following observations were made:

1. Twenty-seven cases are here reported.
2. No cysts were found in any case.
3. Dilated acini were found in the submucosa. Careful measurements demonstrated that these dilated acini were too small to be observed by the naked eye and could not be mistaken for cysts, although on microscopic examination it would be possible to so mistake them (Fig. 10).
4. The fish-scale appearance is due to a spherical enlargement of the ends of the villi. This enlargement is due to an infiltration of leucocytes, fibrosis and other products of inflammation (Figs. 11 and 12). The picture of œdema is different (Fig. 25).
5. The mucosa was always intact except for artefact.
6. The lipid substance was seen in the tips of the epithelial cells lining the lumen and the acini (Fig. 13), around the nuclei and in the base (Figs. 14 and 11), just under the base of the epithelial cells, in large polygonal cells or round cells in the submucosa (Figs. 11, 14, 15, 16 and 17), sparingly in connective-tissue cells and muscle cells, in leucocytes in the stroma (Figs. 21 and 22), in the walls of blood-vessels and in the lumen (Fig. 23). The lipid is usually deposited in fine granules but may become so packed that the granules disappear and the mass is homogeneous (Figs. 15 and 17). The polygonal shape of the large cells in the submucosa is due to their being tightly packed with lipid in a space too small for the spherical shape to be retained (Figs. 17 and 16).
7. Round-cell infiltration was noted in amounts proportional to the amount of lipid deposited.

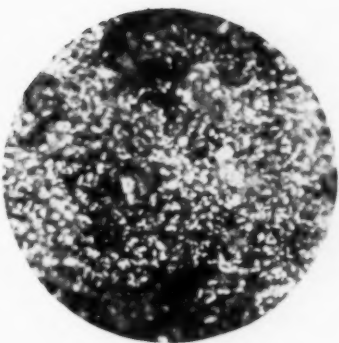


FIG. 1.

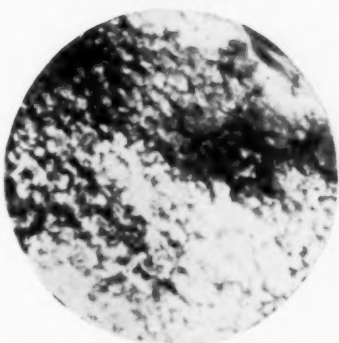


FIG. 2.



FIG. 3.

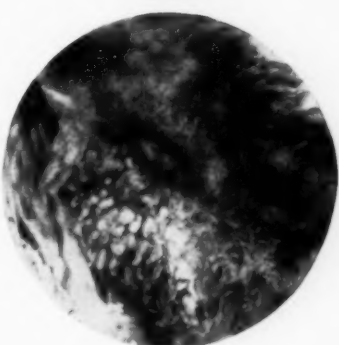


FIG. 4.

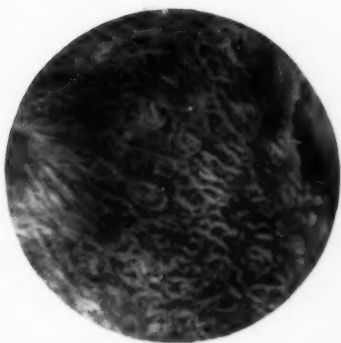


FIG. 5.

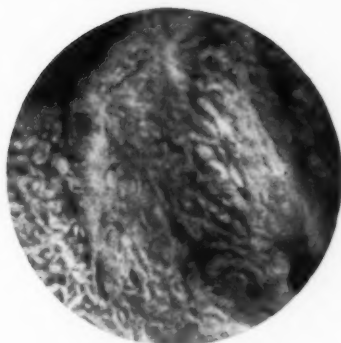


FIG. 6.



FIG. 7.

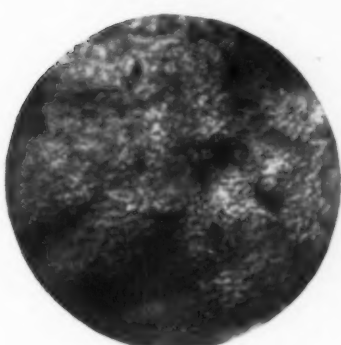


FIG. 8.

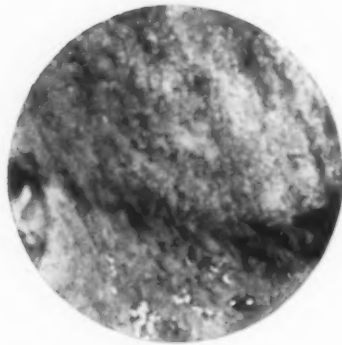


FIG. 9.

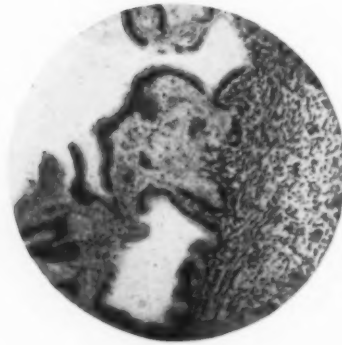


FIG. 10.

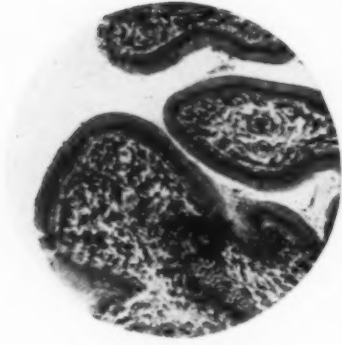


FIG. 11.

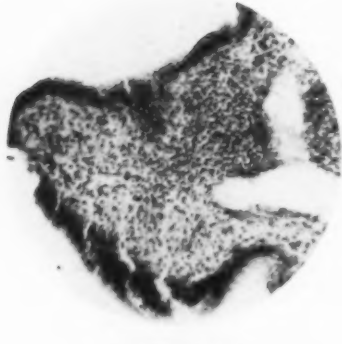


FIG. 12.

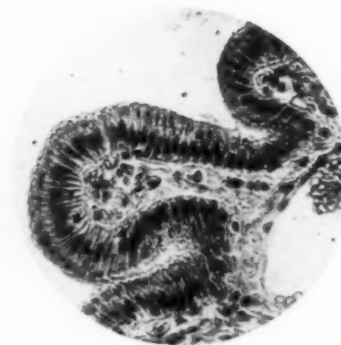


FIG. 13.

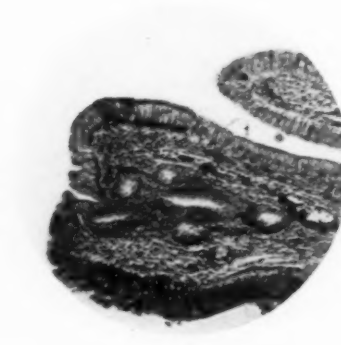


FIG. 14.

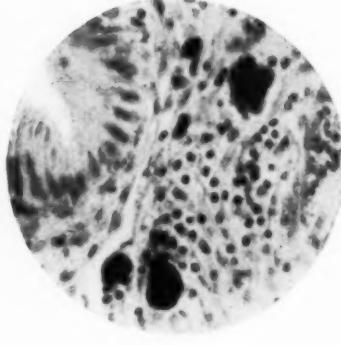


FIG. 15.

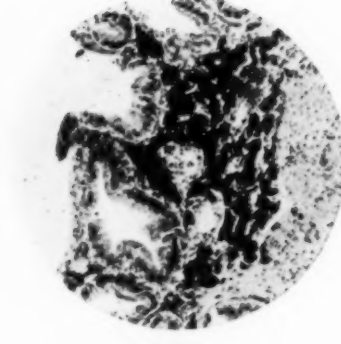


FIG. 16.

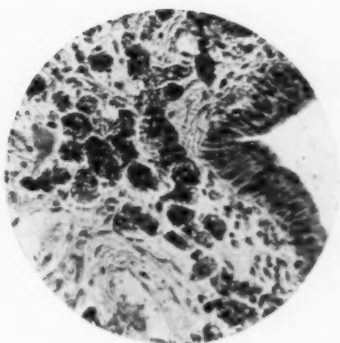


FIG. 17.

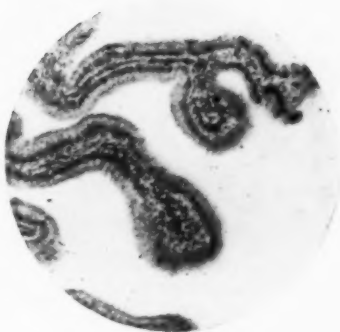


FIG. 18.

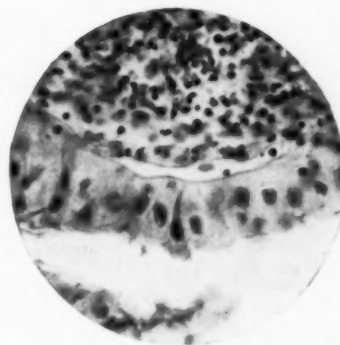


FIG. 19.

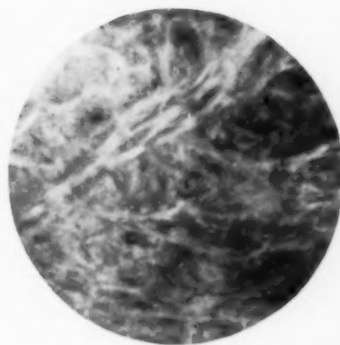


FIG. 20.

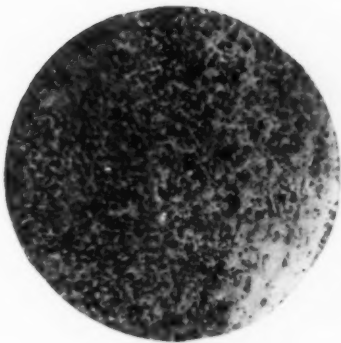


FIG. 21.

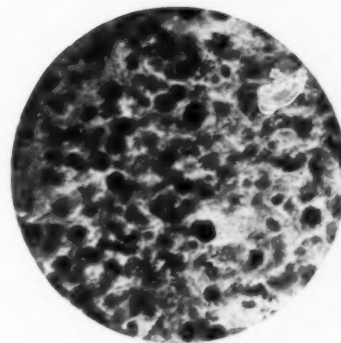


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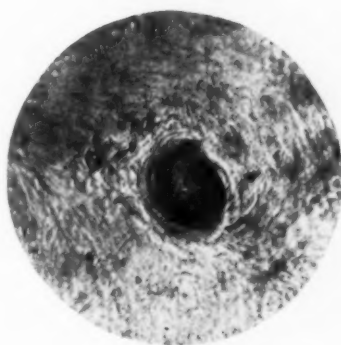


FIG. 23.

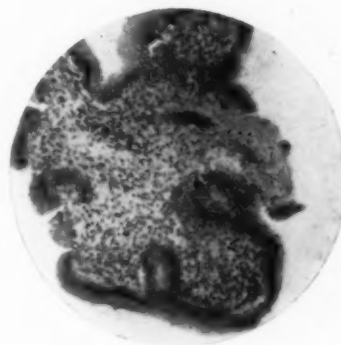


FIG. 24.

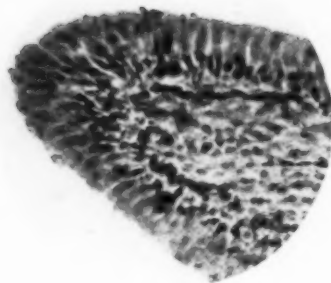


FIG. 28.

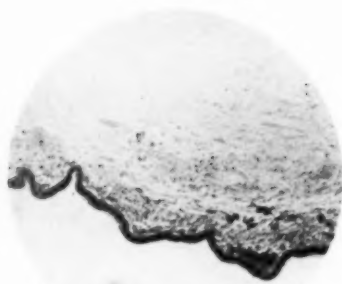


FIG. 27.

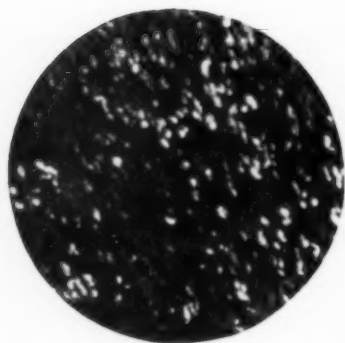


FIG. 26.



FIG. 25.

FISH-SCALE GALL-BLADDER

8. Polynuclear leucocytes were often noted, but the picture was that of an acute infection engrafted on a chronic infection.

9. Fibrosis exists in every case, particularly in the tips of the villi. Round cells may be absent as well as polynuclears and lipoid, but the constant feature is fibrosis. In many of the cases where lipoid could not be seen on visual inspection nor with the 52 mm. lens, it was noted microscopically in small amounts (Figs. 10, 11 and 12).

10. The picture of a normal villus microscopically is not established, but of one nearly normal it may be said that there is a certain amount of round-cell infiltration, that the shape of the villus is slender, delicate, and that the amount of connective tissue in the core of the villus is not out of proportion to the amount of epithelial tissue present (Figs. 13 and 18). As inflammation changes the villus; there is in addition to the usual accompaniments of inflammation a deposition of lipoid, but the greatest change is produced by fibrosis. The villus becomes broader at the base, shorter in long axis, and enlarged at the tip, so as to be almost spherical (Figs 11, 12 and 14). This process goes on till the villus is obliterated and the gall-bladder is lined by a single layer of cuboidal epithelial cells. The whole lumen may become so shrunk that the condition of cholecystitis obliterans supervenes (Figs. 19, 20 and 27).

11. Papillomata were observed with and without the lipoid substance and were identical in other respects (Fig. 24).

CONCLUSIONS

1. "Multiple small cysts of the mucosa" is a misnomer for this condition.
2. Fish-scale appearance is due to chronic inflammation.
3. Lipoid substance leaves an apparent trail from the lumen of the blood-vessel to the lumen of the gall-bladder and is a constant feature in active cholecystitis in this condition.

4. Lipoid substance occurs in leucocytes in fish-scale gall-bladder.
5. The large polygonal cells in the submucosa may be transitional leucocytes.

6. The process of inflammation of the gall-bladder is practically identical with inflammation of the appendix and barring mechanical difficulties the end result is the same, *i.e.*, obliteration.

Acknowledgment is herewith made of encouragement given and opportunities made available by William Carpenter MacCarty, a bio-pathologist.

THE RELATION OF VARIATIONS IN THE RENAL VESSELS TO PYELOTOMY AND NEPHRECTOMY *

BY DANIEL N. EISENDRATH, M.D.
OF CHICAGO, ILL.

OUR text-books of anatomy and even of operative surgery do not always keep pace with surgical needs and progress. This is especially true of anatomical anomalies which may play an important part as causes of serious, if not fatal, accidents. The majority of surgeons have, like myself, become accustomed to think of variations from the so-called normal relations taught in our courses as only of interest to the teacher in the department of anatomy. It is only when we encounter these anomalies in the living that we wonder why their surgical importance was not more forcibly impressed upon us. The occurrence of multiple main renal arteries arising not only from the aorta but from a number of other different sources is mentioned in all of the standard text-books of anatomy. From two up to six renal arteries to one or even both kidneys have been described. Merkel's treatise on anatomy was, in 1901, the first, however, to refer to the surgical importance of accessory vessels to the upper and lower poles of the kidney. The majority of our descriptive anatomies either do not mention them or consider these and similar anomalies as of no practical importance. No illustrations exist in standard atlases, and the only text-books which refer to their occurrence are Cunningham, Quain, Gray, and Piersol. Quain states that accessory vessels are found in 20 per cent. of bodies. Piersol states that accessory renal arteries may arise from the aorta, middle sacral, common and internal iliacs, or even inferior mesenteric, and often enter at other places than the hilus. There are few references in the chapters on the kidney in our text-books of surgery and but little more in the special monographs on the kidney. Israel, in his book published in 1901, refers to a case where post-operative hemorrhage from an overlooked accessory vessel necessitated nephrectomy. Pasteau, in 1901, reported a case of severe bleeding from such a vessel after nephrectomy and reported finding such arteries in 20 per cent. of 82 cases. Schede in the von Bruns system speaks of the surgical importance of accessory vessels and the necessity of watching for them in all strands of fibrous tissue running to the poles of the kidney. Garre, Bockenheimer and Albarran also mention their existence at both poles and the fact that separate ligation may be needed to prevent post-operative bleeding. Ekehorn,¹ in 1907, was the first to direct attention to the part which the accessory vessels to the lower pole may play in the etiology of hydronephrosis. He found such an inferior polar artery

* Read at the meeting of the American Urological Association, held in New York City, March 24, 1920.

VARIATIONS IN THE RENAL VESSELS

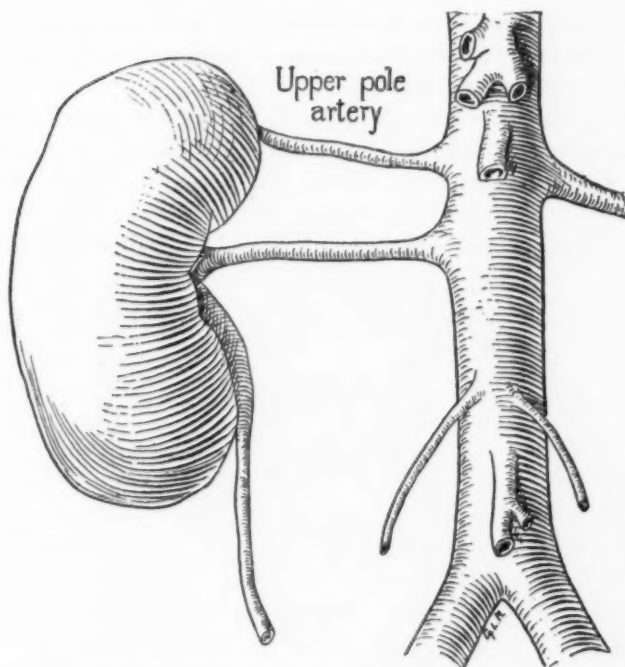


FIG. 1.—Diagram showing origin of upper polar (accessory) artery from the aorta.

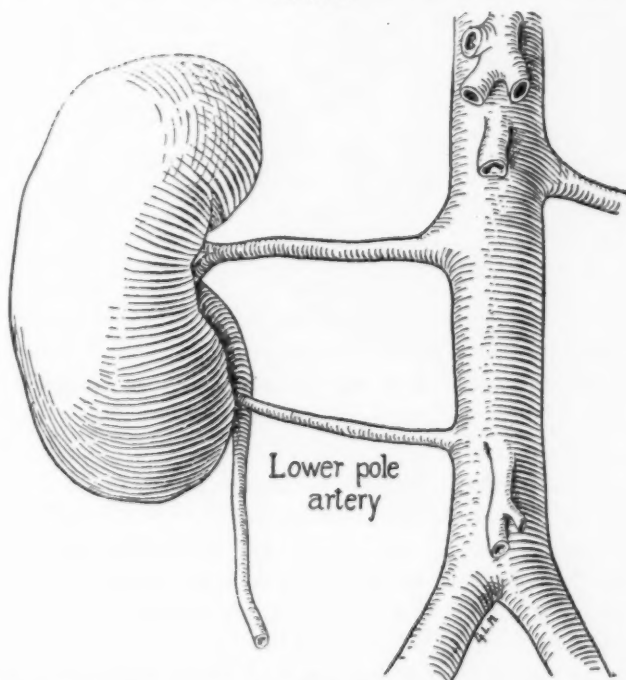


FIG. 2.—Diagram of mode of origin of lower polar (accessory) artery from the aorta.

lying in front of the ureter in 64 and behind it in 84 specimens. Dr. W. J. Mayo² in a later paper reported 20 cases of hydronephrosis due to kinking of the ureter by such an accessory vessel.

The first systematic observations as to the frequency of occurrence of polar, *i.e.*, accessory renal vessels, were those undertaken by the Anatomical Societies of Great Britain and Ireland, published in 1891.³ This was followed by a report in 1909 of the results obtained in the examination of 150 bodies (300 kidneys) by Seldowitsch.⁴ Dr. D. C. Straus⁵ and myself in

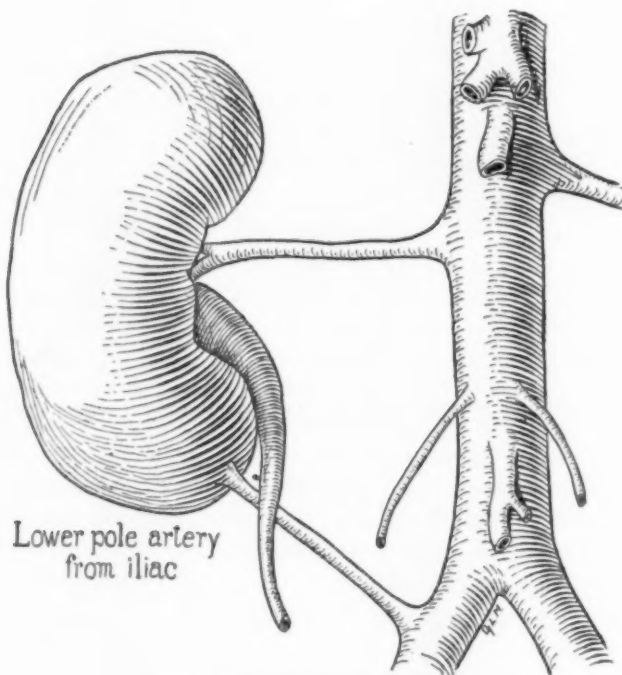


FIG. 3.—Lower pole artery arising from iliac.

1910 reported the frequency of occurrence of such accessory vessels in 100 bodies (200 kidneys), and Rupert⁶ the same in 50 bodies (100 kidneys).

I again became interested in the subject when an accessory artery to the upper pole of the kidney was overlooked during a nephrectomy, resulting in almost uncontrollable bleeding from the stump which had retracted towards its point of origin on the aorta. Having heard of some similar accidents to anomalous blood-vessels during pyelotomy which necessitated nephrectomy, I undertook another investigation which included (a) the frequency of occurrence of polar vessels; (b) the surgical anatomy of the posterior aspect of the renal pelvis; and (c) the various types of renal pelvises and their relative frequency.

A portion of the studies were made in the dissecting rooms of the University of Illinois Medical School, and included the examination of 47



FIG. 4.—Posterior view of kidney showing superior polar artery arising from main renal artery.

VARIATIONS IN THE RENAL VESSELS

bodies. The investigation was resumed later at the Harvard Medical School, where 62 bodies were examined. I desire to express my appreciation of the courtesy of Prof. A. C. Eyclesheimer of the University of

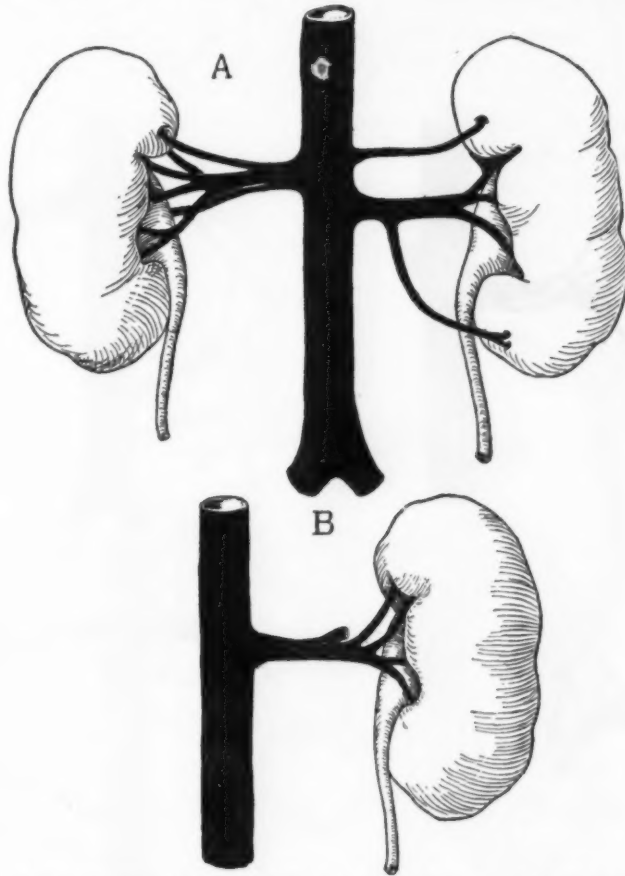


FIG. 5.—A, most important feature is origin of accessory lower polar artery from main renal on left side. B, Posterior view of right kidney of A, showing superior, middle and inferior types of retropericardic arteries.

Illinois and of that of Prof. John Warren and Assistant Prof. H. K. Begg of the Harvard Medical School for placing at my disposal the material upon which these studies are based.

I. FREQUENCY OF OCCURRENCE OF ACCESSORY POLAR ARTERIES

The occurrence of an accessory artery from the aorta to the upper pole (Fig. 1) and of a similar artery from the aorta (Fig. 2) or one of the iliacs (Fig. 3) to the lower pole, are the only vessels referred to in all previous investigations except those of Doctor Straus and myself. In our previous paper (see Table I) we reported the presence of a superior polar artery arising from the renal as a relatively frequent occurrence.

A. Superior Polar Artery Arising from the Main Renal Artery.—As a rule, such an accessory vessel to the upper pole is very short and arises from the main renal shortly before the latter enters the hilus (Fig. 4). That the origin of the accessory vessel may be further back, *i.e.*, closer to the aorta, has never been referred to by other investigators. It can be readily seen (Figs. 5, 6, 7, 8, 10, 19 and 20). In the two latter specimens

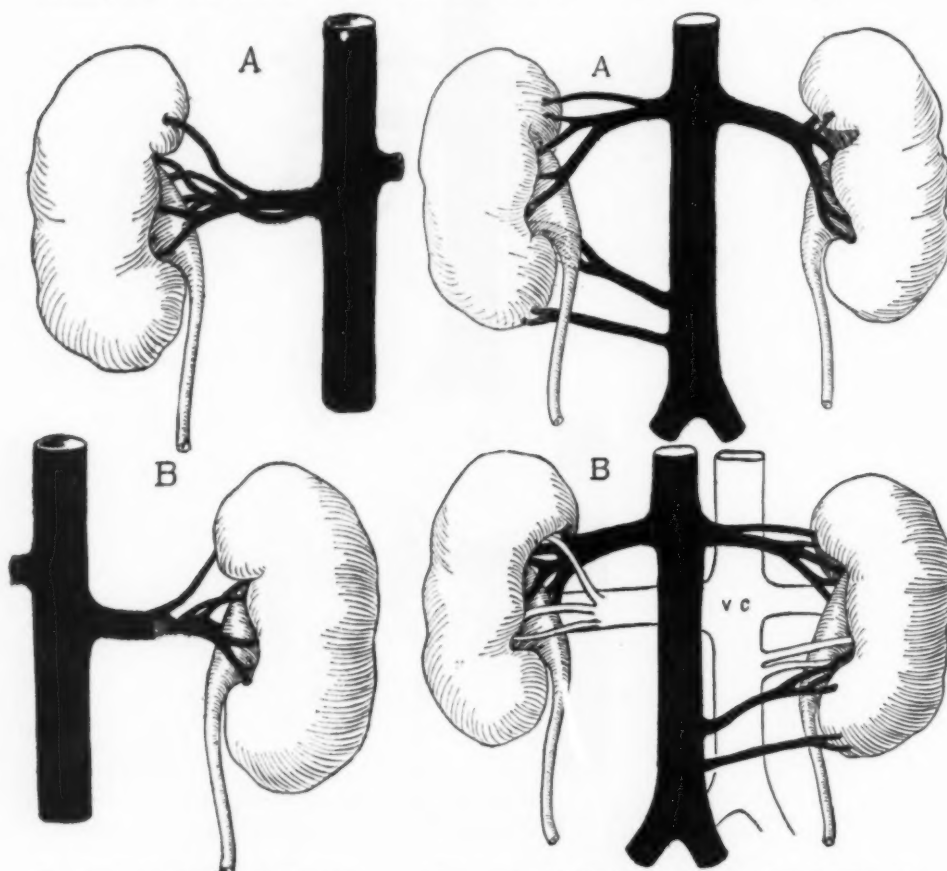


FIG. 6.—*A*, anterior view of right kidney showing accessory superior polar artery arising from renal and also division of main renal artery into equal sized pre- and retroperitoneal branches. *B*, posterior view of *A*, showing fan-like distribution of retroperitoneal artery as in Fig. 5.

FIG. 7.—*A*, chief feature is presence of an inferior polar artery on right side. The lower of two main renal arteries crosses the posterior aspect of the pelvis. *B*, posterior view of *A*, showing two retroperitoneal veins on each side crossing middle of back of pelvis. Note accessory artery crossing posterior aspect of pelvis.

the superior polar arose from the main renal artery so near the aorta that for all surgical purposes it had the same significance as those which arise directly from the aorta, as is the case on the opposite side in the specimen from which Fig. 20 was drawn. One can readily see how a long superior polar from the main renal could be torn as easily as one directly from the aorta, and also how a short one can escape being included in the ligation or clamping of the renal pedicle. A superior polar artery

VARIATIONS IN THE RENAL VESSELS

arising from the main renal was found in 19 kidneys (9.5 per cent.) in our first, and in 49 kidneys (22.2 per cent.) in the more recent investigation. This larger number is due to the fact that such accessory vessels were overlooked in our earlier dissections, and thought to be a branch of the main renal to the hilus instead of to the upper pole.

B. Superior Polar Artery from the Aorta (Figs. 5, 11, 12 and 16).—These are the vessels usually described as the only ones entering the upper pole and not separated by all previous writers from those just described. They usually enter the mesial border; rarely either the anterior or posterior surfaces of the kidney. As a rule, there is only one superior polar artery arising from the aorta and they are found with about equal frequency on both sides. At times there is a superior polar

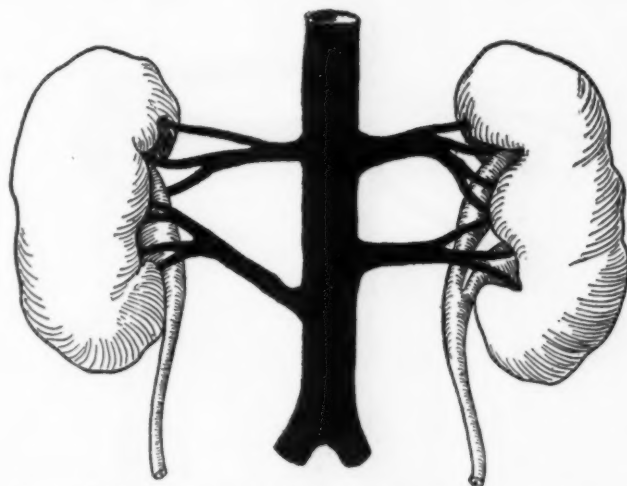


FIG. 8.—Front view showing on both sides a superior polar artery arising from the main renal artery. On left side is seen a typical example of bifid pelvis.

to each kidney. In our first series we found a superior polar arising from the aorta in 5 kidneys (2.5 per cent.), and in the present dissections the percentage is higher, *viz.*, 5.9 per cent. (13 kidneys).

C. Inferior Polar from Main Renal Artery (Fig. 5).—We did not find this mode of origin in our first series, and I have only observed its occurrence once in the present series of dissections. In this case the accessory vessel to the lower pole arose from the main renal (Fig. 5), and could have been easily overlooked in freeing the lower pole.

D. Inferior Polar Arteries from the Aorta (Figs. 7, 9, 10, 11, 12, 13, 17 and 19).—These are of great importance from the standpoint of their relation to compression of the ureter with resultant obstruction (Fig. 22) as well as their being torn during nephrectomy (Fig. 23) with resultant retraction of the bleeding stump toward the point of origin of the vessel from the aorta. At times the latter is quite close to the iliacs (Fig. 19).

The bilateral occurrence of inferior polars is not uncommon (Figs. 13, 17 and 19). The same is true of the presence of two inferior polar accessory arteries, and of the fact that they are more often accompanied by a corresponding inferior polar vein (Fig. 22) than is the case with the superior polar artery. When two main renal arteries are present they may be so far apart that one of them is easily mistaken, as in Fig. 7, for an accessory lower polar artery. The specimen from which *B* of Fig. 10 was made shows that the origin of the inferior polar artery from the aorta may not be opposite the lower pole but a considerable distance higher up. I did not

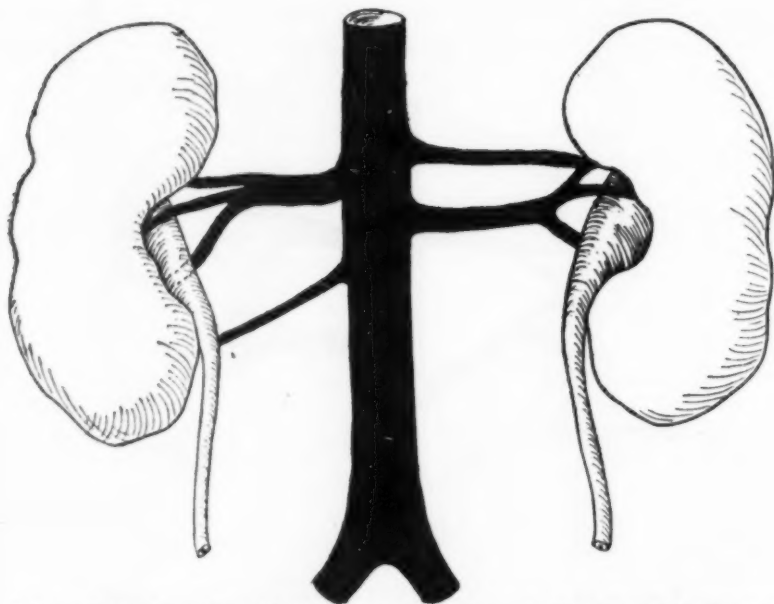


FIG. 9.—Retropelvic artery arising from renal and crossing, as in Fig. 7, the middle of posterior aspect of pelvis. Note lower polar accessory artery direct from aorta.

attempt to make any observations as to how often the inferior polar artery was in front or behind the ureter.

In our first series (Table I) we found 7 (3 per cent.) inferior polars arising from the aorta, and in the present one I have observed it in 31 kidneys (13.1 per cent.).

E. Inferior Polar Arising from the Iliacs.—As in our previous investigation this has been only noted as having occurred (Fig. 3) once. In the Collective Investigation³ by the Anatomical Societies of Great Britain and Ireland on 419 bodies, inferior polars from the iliacs were found in 4 (0.9 per cent.), *i.e.*, about the same as in our two series. Seldowitsch and Rupert do not mention the frequency of origin of accessory lower polar vessels from the iliacs. It is well known that in addition to arising from the common and internal iliacs, lower polar renal vessels may arise from the middle, sacral, or even the inferior mesenteric.

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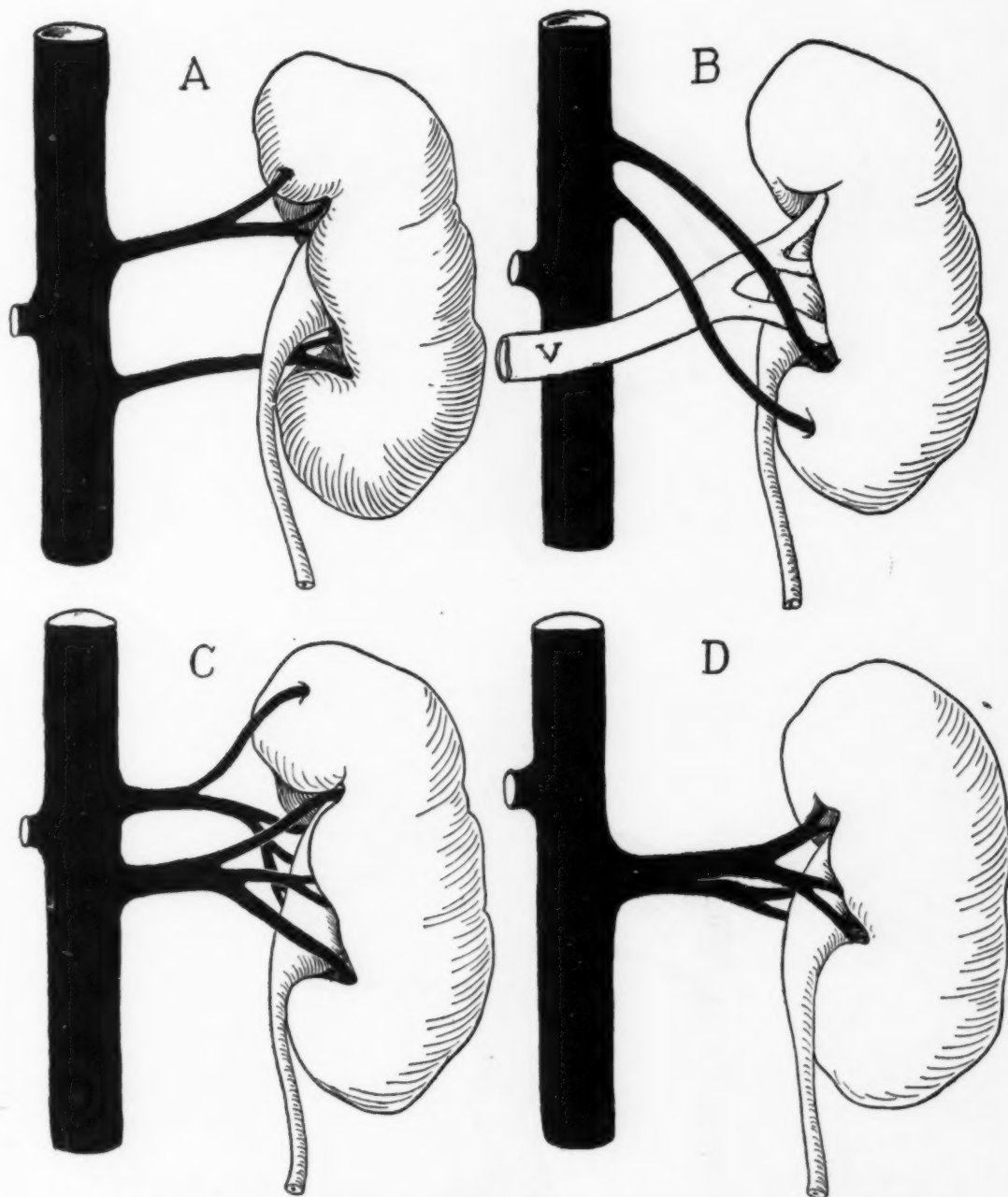


FIG. 10.—A, superior polar artery arising from one of two main renals. B, accessory artery to lower pole crossing renal vein obliquely. This specimen shows how difficult it would be to secure the bleeding trunk if such an artery were overlooked. C, upper of two main renal arteries gives off a superior polar artery, and a retropelvic artery. D, main renal artery divides into pre- and retropelvic branches of equal size.

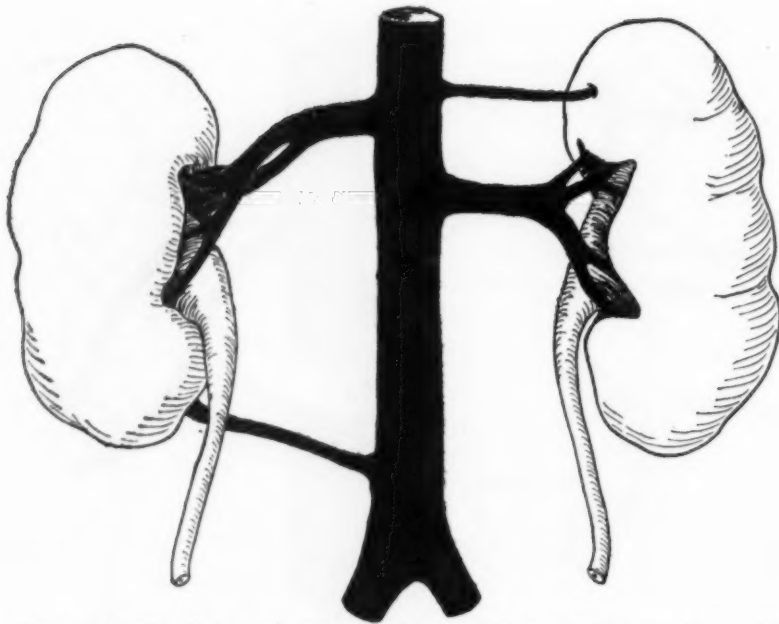


FIG. 12.—On right side is seen a typical division of the main renal into pre- and retropelvic branches of equal size. Note lower polar accessory artery to right kidney lying behind ureter. There is also an accessory superior polar on the left side.

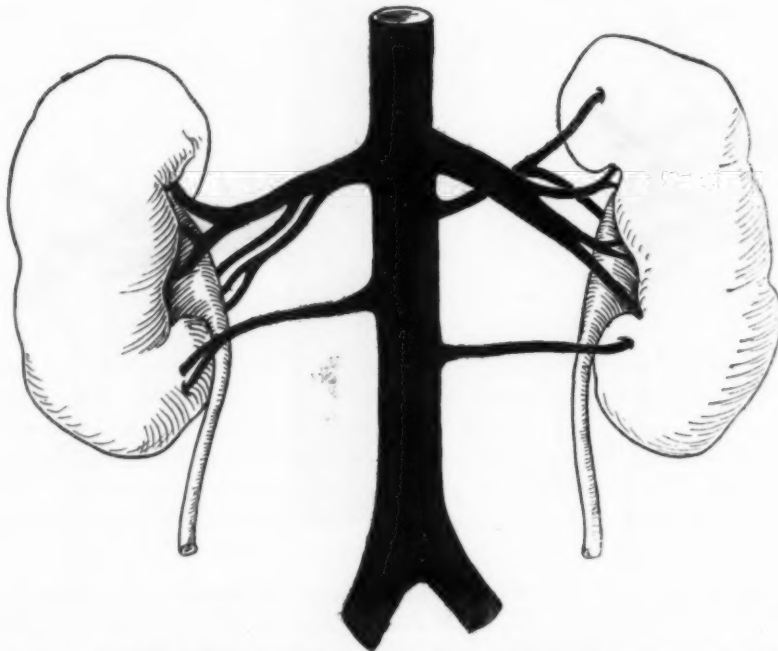


FIG. 13.—Anterior view showing retropelvic artery on right side arising from renal, close to aorta. On the left side note the superior polar and the retropelvic artery, both arising from one of two main renals. Note inferior polar (accessory) arteries arising from aorta on both sides.

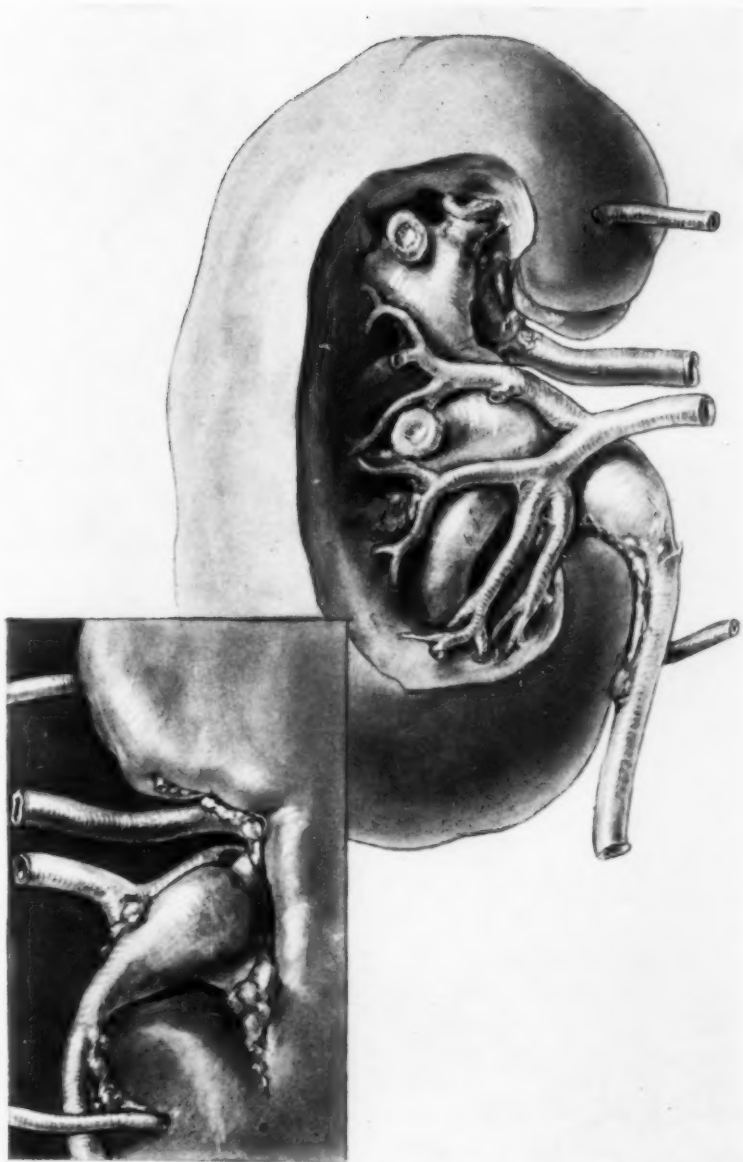


FIG. 11.—Anterior view of kidney showing relation of main renal artery to front of pelvis. There is a second main renal artery which is entirely retropelvic. Note accessory polar arteries to upper and lower poles, well shown in insert.



FIG. 14.—Posterior view of kidney showing relation of retropelvic artery to back of pelvis.

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COMPARISON OF RESULTS OF UNIVERSITY OF ILLINOIS AND HARVARD DISSECTIONS

University of Illinois Dissections (made in 1915).—There were 47 bodies, *i.e.*, 94 kidneys. Upper polars from renals were found in 28, or 29.7 per cent. Upper polars from the aorta present in 7, or 7.4 per cent. There were lower polars from the renals, but these were found arising from the aorta in 16, or 17 per cent., and from the common iliac in 1, or .9 per cent.

Harvard Medical School Dissections (made in 1919).—There were 62 bodies, *i.e.*, 124 kidneys. Upper polars from the renals were found in 21, or 16 per cent. Upper polars from the renals were present in 6, or nearly .5 per cent. There was one lower polar from the main renal, 15 lower polars from the aorta, *i.e.*, 15.9 per cent., and none from the iliacs.

We note a discrepancy in the upper polars in the two series of dissections, but practically none between the frequency as regards the lower polars.

TABLE I

	No. of kidneys	Normal	Aortic upper polars	Renal upper polars	Aortic lower polars	Iliac lower polars	Renal lower polars
Collective investigation *	419	369 (89%)	29 (6%)	.....	17 (4%)	4 (.9%)	.....
Seldowitsch *	300	288 (96%)	4 (1.3%)	.....	8 (2.7%)	.....	.....
Eisendrath and Strauss *	200	168 (87.6%)	5 (2.5%)	19 (9.5%)	7 (3%)	1 (.5%)	.....
Rupert *	100	75 (75%)	17 (17%)	.....	8 (8%)	.....	.....
Eisendrath (present paper)	218	123 (54.6%)	13 (5.9%)	49 (22.2%)	31 (13.1%)	1 (2.1%)	1 (2.1%)

PRACTICAL CONCLUSIONS FROM ALL PUBLISHED STATISTICS

It is of importance for the surgeon to remember that the examination of 1237 kidneys by various investigators reveals the fact that upper polars from the renals (see Table I) occurred in 68, or 16 per cent., of 418 kidneys. Upper polars from the aorta were found in 68, or .5 per cent., and lower polars from the aorta in 71, or nearly .6 per cent., of 1237 kidneys. Lower polars from the iliacs were found in only 6, or .04 per cent., of the 1237 kidneys.

According to my present series of dissections, one can expect to find upper polar arteries arising from the main renals in about one kidney out of five. Upper polars arising from the aorta were found in one out of about 17 kidneys and lower polars (from the aorta and iliacs) in one kidney out of about 7 kidneys.

Adding together the observations of all previous investigators and our own we find that (a) upper polars arising from the main renals occur in about one out of 200 kidneys; (b) upper polars arising from the aorta in about one out of about 190 kidneys, and (c) lower polars from the main renal, the aorta, or common iliacs in one out of about 185 kidneys. Although accessory polar vessels do not occur as frequently as stated by Quain, *i.e.*, 20 per cent., they are found often enough to be constantly borne in mind during operation (Figs. 23 and 24).

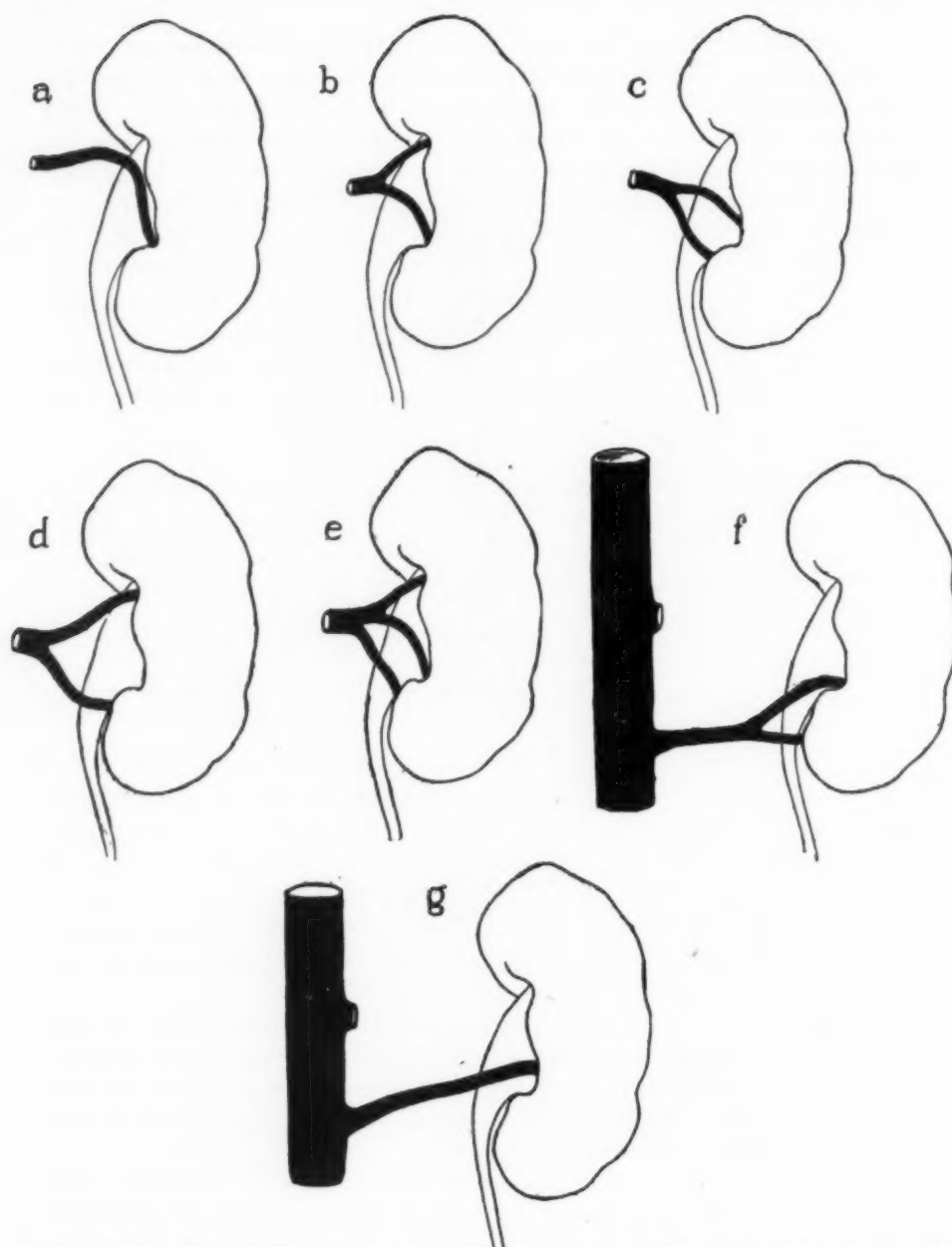


FIG. 15.—Diagrammatic representation of various forms of retropelvic arteries. *a*, typical single retropelvic artery forming an arch at uppermost portion of renal pelvis (see also Fig. 14). *b*, upper and middle retropelvic arteries. *c*, lower and middle retropelvic arteries. *d*, lower and upper retropelvic arteries. *e*, fan-like retropelvic artery, there being a middle, upper and lower branch (see also Figs. 5 and 16). *f*, retropelvic artery arising from a lower polar accessory artery. *g*, retropelvic artery directly from aorta (Fig. 7).

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II. THE RETROPELVIC VESSELS

The tradition still exists that one needs only to guard against injury of a retropelvic artery which pursues a more or less typical course in the sinuses formed at the point where the kidney tissue slightly overlaps (Fig. 25) the renal pelvis. That there may be (a) variations from this arch-like distribution of the artery and (b) that one or more large veins, even the main renal, may cross our field of operations are two anatomical

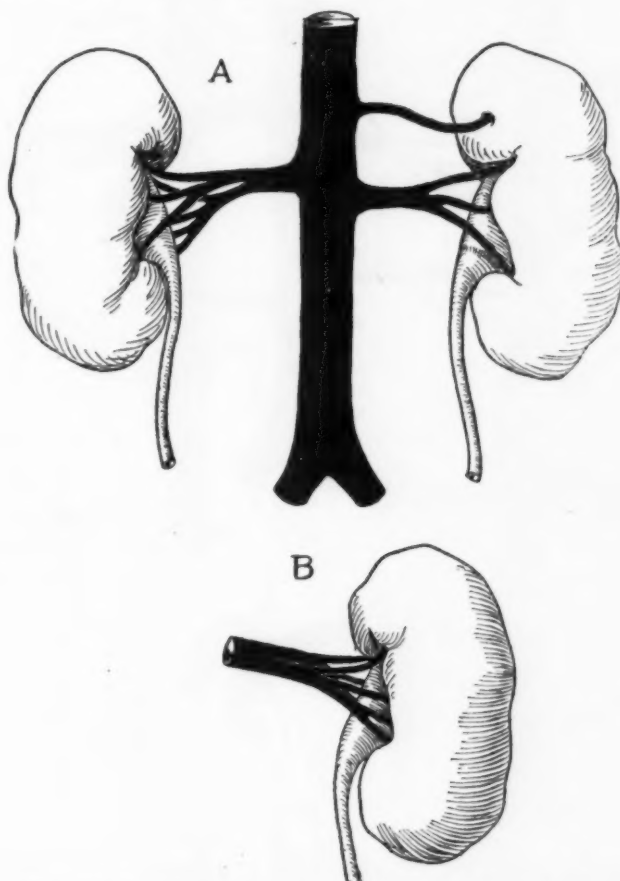


FIG. 16.—A, right kidney. Typical example on right side of division of main renal artery into equal sized pre- and retroperic branches. B, example of fan-like division of retroperic artery over posterior aspect of pelvis.

facts which deserve more widespread knowledge in order to avoid injury to these anomalous vessels during pyelotomy.

In Albarran's book, published in 1910, reference is made to retroperic artery and vein to the effect that the main renal artery may divide into pre- and retroperic trunks of equal size, and that the retroperic artery on its way to the sinus gives off branches similar to those arising from the prepelvic artery. His only statement in regard to the retroperic

vein is that it is not constant—was found in 5 of 29 cases by Hauch—and finally that it may prove a source of trouble during pyelotomy.

In view of the results of my present dissections, I believe we must abandon the view that the posterior aspect of the renal pelvis is the avascular field which we have generally believed it to be. The distribution of the prepelvic (Fig. 11) vessels seldom, if ever, enters into con-

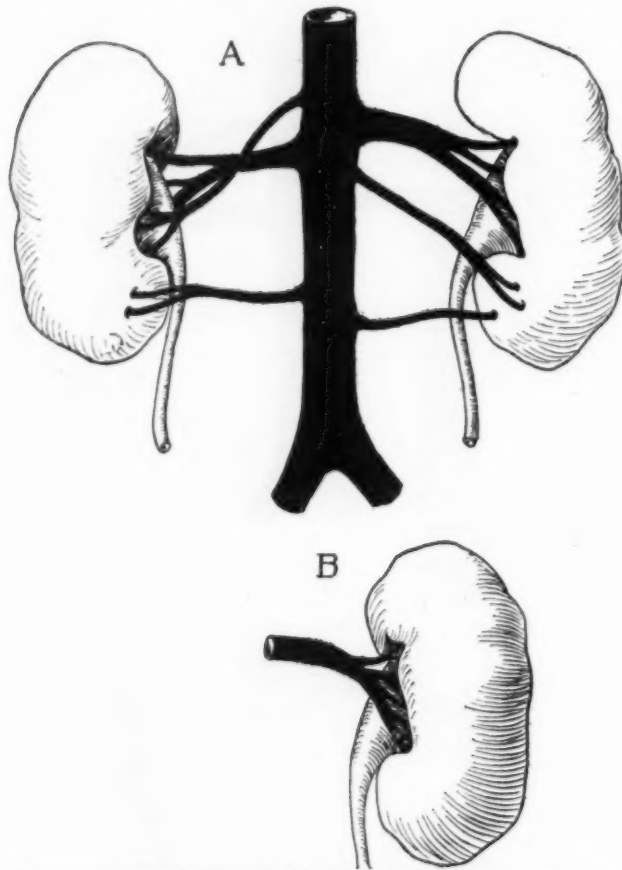


FIG. 17.—A, anterior view. Right kidney shows a single accessory artery to lower pole. Left kidney shows two accessory arteries to lower pole, all from aorta. B, posterior view of right kidney showing typical fan-like distribution of retropelvic artery.

sideration in the operation of pyelotomy, because the route of election is through the less vascular (Fig. 25) field.

In a total of 218 kidneys, the following observations of variations of the retropelvic vessels of surgical importance were made:

A. Anomalies of the Retropelvic Artery Alone.

1. Division of the single main renal artery into equal-sized branches was found (Figs. 6, 7, D of Fig. 10, 12, and 16) very frequently.

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2. When there were two main renal arteries, one of these frequently became the retropelvic, *i.e.*, the latter arose directly from the aorta (*c* in Fig. 10 and Fig. 17) instead of the main renal artery. This was found in 5 kidneys out of 124 (Harvard).

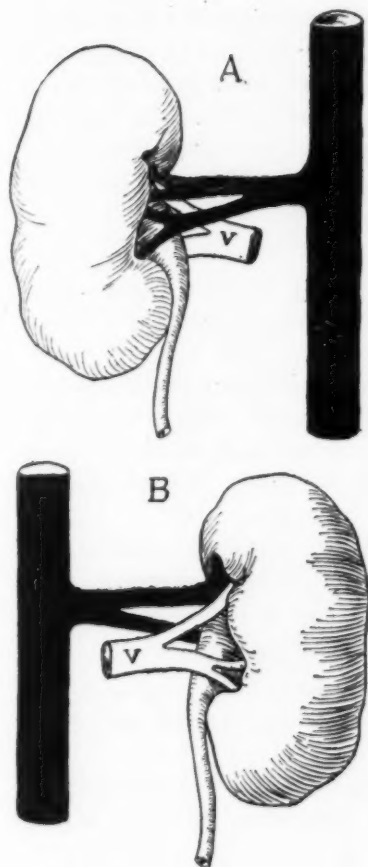


FIG. 18.—Anterior (A) and posterior (B) views of right kidney showing main renal vein crossing posterior aspect of pelvis.

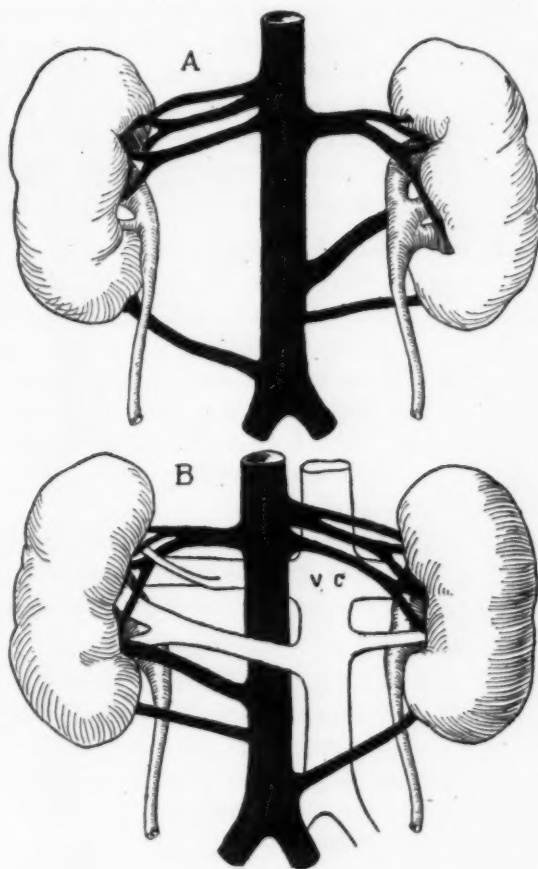


FIG. 19.—A, right kidney. Accessory upper polar artery arising close to aorta from one of two main renal arteries. Note also accessory lower polar artery arising from aorta close to common iliac. Similar condition in left kidney but superior polar artery arises from one of two main renals close to kidney. B, posterior view of A, showing a large renal vein and artery entering kidney back of pelvis on left side, and a smaller retropelvic vein directly from the vena cava.

3. The main renal or one of two renal arteries was found to be retropelvic (Fig. 7) in 2 kidneys out of 124 (Harvard).
4. The retropelvic artery had its origin from an accessory lower polar artery in 2 kidneys (*f* of Fig. 15) out of 124 (Harvard).
5. A retropelvic artery (Fig. 7) directly from the aorta was found in 2 kidneys out of 124 (Harvard).

6. The main retropelvic artery does not cling in an arch-like manner to the renal sinus. This generally accepted course of the vessel may be described as the high type (*a* in Fig. 15), to distinguish it from various combinations which were found in both the Illinois and Harvard dissections. These extra vessels which may give rise to troublesome bleeding during pyelotomy are (*a*) a high middle and low or fan-like distribution (Figs. 5 and 17) found twice in 124 kidneys; (*b*) a high and middle type of branching (Fig. 15) found twice in 124 kidneys; (*c*) a high and low type (Fig. 15) found twice in 124 kidneys; (*d*) a single artery crossing the middle of the pelvis, found four times in 124 kidneys; and finally, (*e*) a middle and low type found seven times in 124 kidneys.

B. Anomalies of the Retropelvic Veins.

1. One large vein arising from the vena cava (Fig. 21) was found five times in 218 kidneys, passing directly across the back of the renal pelvis.
2. The main renal vein divided into equal size pre and retropelvic (Fig. 21) branches in 3 of 218 kidneys. The retropelvic branch passed directly across the pelvis and, as in the case of the preceding anomaly, could be easily injured during pyelotomy.
3. The most important anomaly, so far as the veins were concerned, was that the main renal vein, instead of being prepelvic, was retropelvic in 9 out of 218 kidneys (Fig. 21).

C. Anomalies Involving Both Retropelvic Vein and Artery.

1. One large vein directly from the vena cava (Fig. 21) and one artery directly from the aorta crossed the back of the pelvis in one of 94 kidneys (Harvard).
2. Two large veins directly from the vena cava and one artery from the aorta crossed the back of the pelvis in one of 94 kidneys (Harvard).

III. TYPES OF PELVIS

Observations made as to the relative frequency of the various types of renal pelvis revealed the following:

1. The single or ampullary (Fig. 4) pelvis was found in 84 (89 per cent.) out of 94 kidneys.
2. The divided or bifid (Fig. 27) type was found in 7 (8 per cent.) out of 94 kidneys. In 4 of these it was present on both sides.
3. The trifid type (Fig. 27) was found in 3 per cent. of 94 kidneys.

MODE OF ORIGIN OF ANOMALIES OF THE RENAL VESSELS

Thanks to the investigations of Jeidell⁷ and Bremer⁸ this question has at last been cleared up and I can warmly recommend the reading of these

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articles in the original to those interested in the subject. I shall simply quote the conclusions of Bremer, which are as follows:

1. The anomalies of the renal artery depend on vessels present in the embryo before the aorta and its larger branches develop mesodermal coats. There are no "late branches."

2. Certain anomalies are due to the persistence of the early renal blood supply most frequently seen with pelvic kidneys, that is, the renal

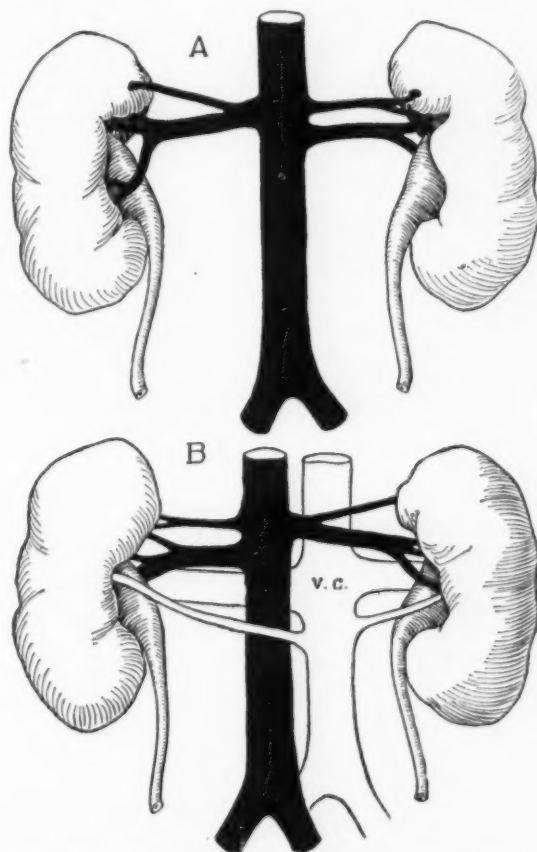


FIG. 20.—A, front view showing superior polar artery arising from main renal on right side and from aorta on left side. B, posterior view of A, showing a fairly large renal vein crossing middle of back of pelvis.

artery as a branch of the iliac, inferior mesenteric, or middle sacral arteries or from the aorta below the inferior mesenteric artery.

3. A periaortic plexus of vessels with many roots from the aorta exists, which affords an opportunity for the change of position of main aortic branches and of supplying smaller branches for possible future use.

4. The renal artery is derived from this plexus and the channel for the permanent renal artery is selected mechanically. Channels not so

convenient may be utilized if the usual channel is occluded, hence the renal variations and anomalies.

These investigations explain to my mind why not only the mode of origin of the renal artery is largely a matter of chance, but also why there may be multiple main renal arteries and veins as well as all varieties

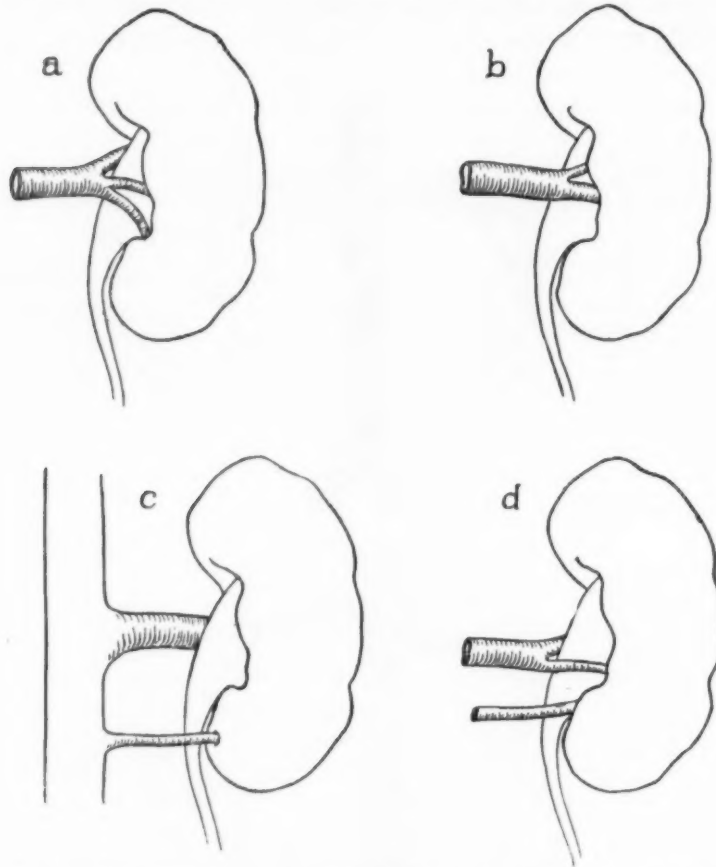


FIG. 21.—Diagrammatic representation of various types of retropelvic veins: a, division of the main renal vein into pre- and retropelvic branches of equal size; b, main renal vein crosses posterior aspect of pelvis to reach kidney; c, accessory renal vein to lower pole of kidney; d, main renal vein divides into two branches, the larger of which is retropelvic. There is also an accessory renal vein directly from aorta.

of accessory vessels, depending upon which channel from the periaortic plexus is utilized to furnish blood supply to the kidney after it has migrated from its original embryonic pelvic position to its permanent one.

SUGGESTIONS FOR CHANGES IN THE TECHNIC OF NEPHRECTOMY AND PYELOTOMY

In view of the relative frequency of the anomalies which have been found, I believe that the following changes in our technic are advisable:

1. During nephrectomy or even nephrotomy the poles of the kidney

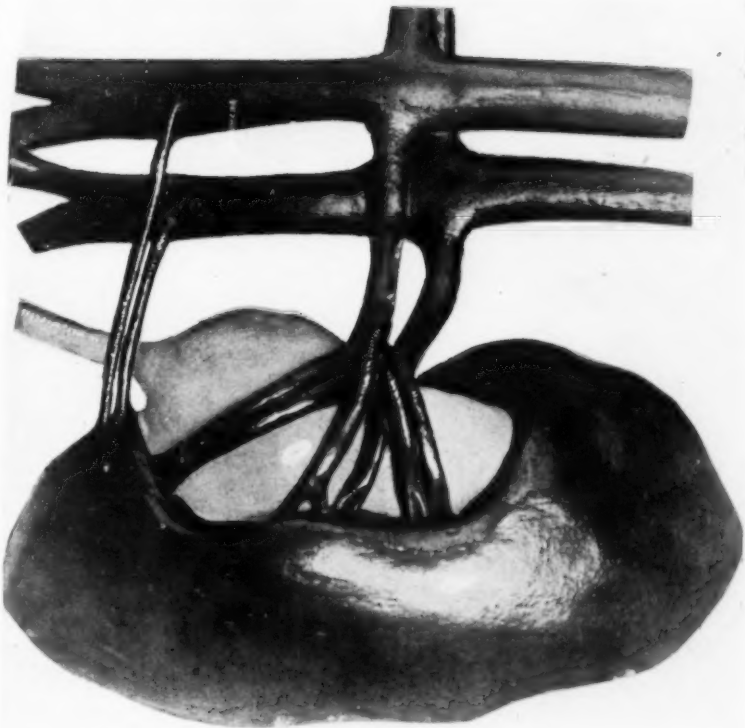


FIG. 22.—Hydronephrosis due to accessory polar artery. Note accessory lower polar artery and vein. (Photograph of model from author's case.)



FIG. 23.—Exposure of lower pole of kidney in search for accessory arteries. (Kindly loaned from one of author's articles by W. B. Saunders Co.)



FIG. 24.—Exposure of upper pole of kidney in search for accessory arteries. (Kindly loaned by W. B. Saunders Co.)

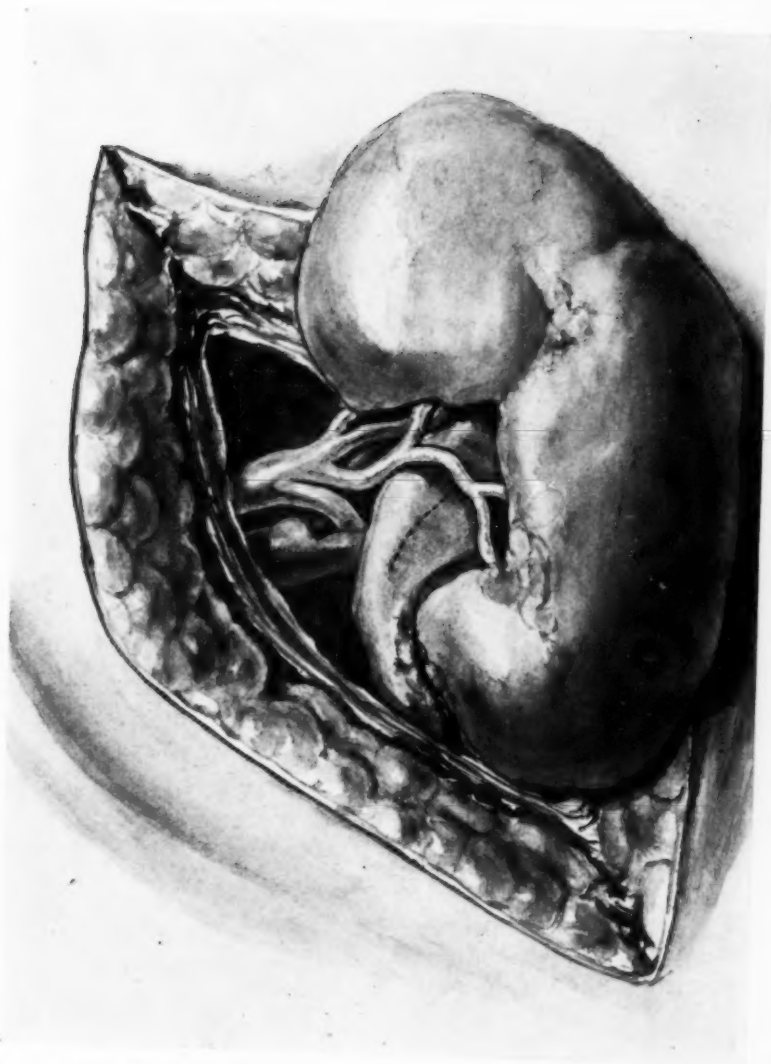


FIG. 25.—Field of operation in pyelotomy. Note how pelvis is crossed close to renal sinus by high type retropericardic artery. Dotted line shows incision usually made for delivery of calculus.

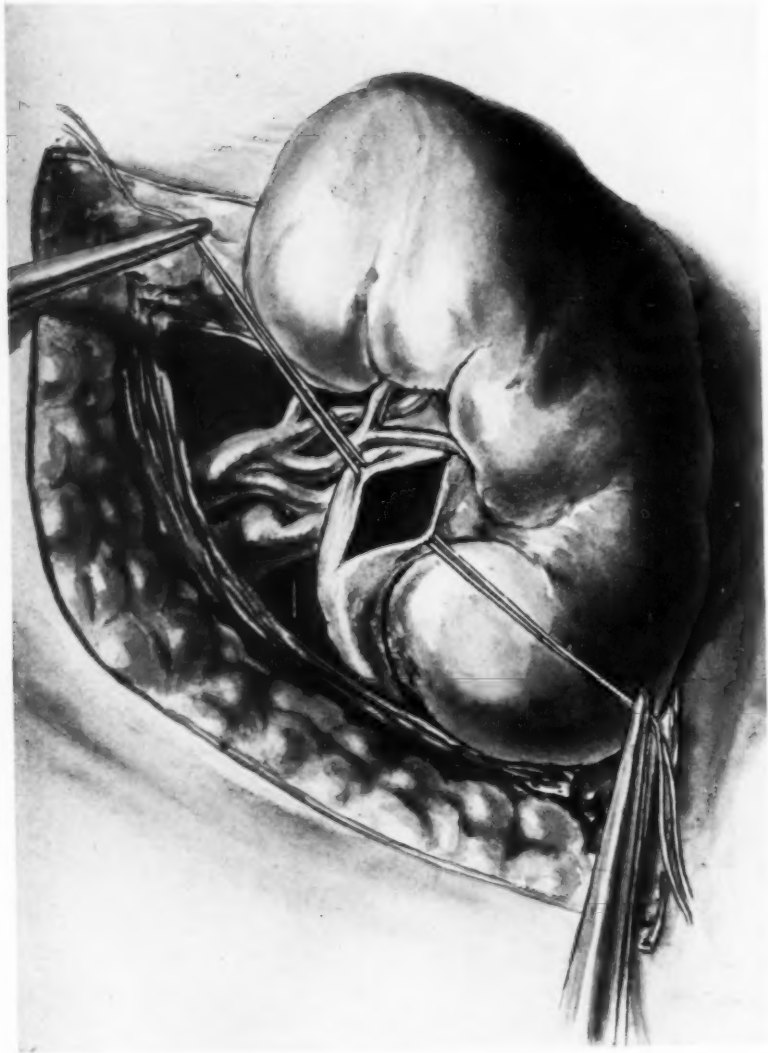


FIG. 26.—Same as Fig. 25, showing pelvis open and edges retracted by catgut guy ropes.

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should be most carefully exposed. The mobilization of the kidney should be gradual, care being taken both at the lower (Fig. 23) and upper (Fig. 24) poles never to tear or divide adhesions or strands of fibrous tissue before they have been inspected and also palpated (for a possible pulsation) to exclude the presence of a supernumerary vessel. I have

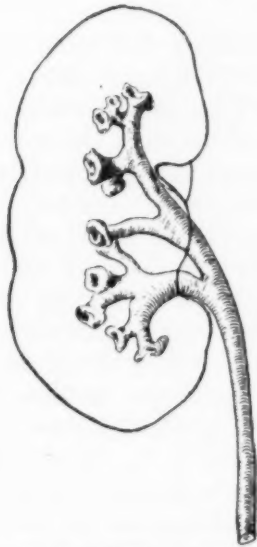


FIG. 27.—Bifid or double type of pelvis. Note that the division begins external to the renal hilus.

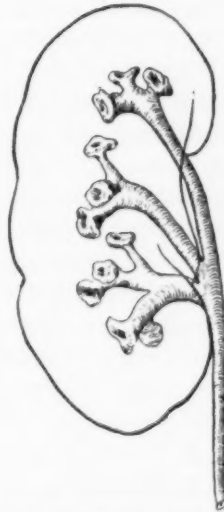


FIG. 28.—Trifid or triple type of pelvis. Note that the division begins external to the renal hilus.

found the suggestion of Kolisher an excellent one, namely, to divide the ureter in nephrectomy before attempting to mobilize the kidney.

2. In pyelotomy one must bear in mind the anomalies of the retro-pelvic vessels which I believe have been reported for the first time in this paper. Careful exposure of the pelvis (Fig. 25) before the incision for delivery of a calculus (Fig. 26) is made will greatly lessen the chances of encountering an anomalous vein or artery.

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MODIFIED TECHNIC FOR THE RADICAL CURE OF INGUINAL HERNIA IN THE MALE

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THAT so many methods have been and are still being advocated for the repair of inguinal hernia is rather convincing evidence that no one method is as yet quite perfect and that there is still room for improvement. Were it not for this fact, I would not have the temerity to add another modification to the long list of operative procedures for this condition with which the surgical literature is already flooded. Although it must be conceded, before going further, that most of the standard modern operations for inguinal hernia, particularly for recent, indirect herniæ in children or young adults, give on the whole, if properly performed, fairly satisfactory results, nevertheless the final word has apparently not yet been written regarding them. Barring the Macewen and Kocher operations, which have lost their popularity in this country, these operations are all more or less based upon the primary Bassini or Halsted technic. Whether the cord is transplanted as in the original Bassini, original Halsted, posterior Andrews, Fournel, Hackenbruch, or Torek operation, or whether the cord is left in place as in the Bull-Coley, Wölfler, or modified Ferguson, without overlapping of the external oblique aponeurosis, or in the Girard, anterior Andrews, or improved Halsted (so-called Johns Hopkins) method, with imbrication of the aponeurosis, the essential principle is the removal of the sac and the closure of the hernial orifice by a suture of the internal oblique muscle and conjoined tendon to Poupart's ligament.

The modification which I am about to describe also has the Bassini and Halsted operations as its progenitors. Certain desirable features from several former modifications of these operations have been incorporated in it. It differs from all the other procedures, however, in that it utilizes, to the fullest extent, *all* the useful, available structures for the actual repair of the hernial orifice, without mutilation or distortion, and insures a maximum guarantee against recurrence. Essentially it consists in the overlapping of the external oblique aponeurosis beneath the transplanted cord and over the Bassini suture. To use a phrase that Meltzer has aptly applied to medicine, I believe that it offers the greatest possible "factors of safety."

In the course of the classical Bassini operation I had always been impressed by the fact that the result of the operation hinges upon the success of the frequently doubtful, solitary suture line between the internal oblique muscle and conjoined tendon and Poupart's ligament. If union here should not be satisfactory, if a suture should cut through or open, if the

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muscle or tendon is atrophic or undeveloped, if the ligament is thin or tears, the chances are that the hernia will recur. The aponeurosis of the external oblique, in the Bassini or in its various modifications with cord transplantation, is either only partly used, as in the posterior Andrews, Fournel, or Hackenbruch, or is not used at all for the actual repair of the hernia, but is sutured over the cord as an entirely superfluous, nay, even an injurious covering. Here it has no effect, whatsoever, in preventing a recurrence, but often only tends to angulate and compress the cord and interfere with the spermatic circulation. Although the inadequacy of the single suture line is partially overcome by the suture of the upper flap of the aponeurosis to Poupart's beneath the cord, as in the posterior Andrews and kindred operations, the positive disadvantages referred to are then especially evident because the lower flap alone is sewed over the cord. The aponeurotic covering of the cord is thus of necessity tight and the cord is squeezed between the two inelastic flaps of aponeurosis. In the various operations in which the cord is not transplanted, whether the aponeurosis is overlapped or not, the possibility of a recurrence always exists at the point of emergence of the cord at the medial angle of the plastic. The consensus of opinion, as recently expressed by Masson and confirmed by statistics, seems to be that this danger of recurrence is certainly greater than in those operations in which the cord has been transplanted. Although it is less likely in the indirect type, a new sac may form and slide down the inguinal canal under the suture line, emerging at the ring. I believe it is universally conceded that in the direct type of hernia, any operation in which the cord is not transplanted is bad, especially if the hernial opening is near the pubic spine. As evidence of this, it might be observed that most of the surgeons, who have abandoned the transplanting step as a routine measure, still use it in direct herniæ. The modified technic, which I have adopted, effects the greatest possible transplantation of the cord. Its description follows:

In all except young children and very nervous adults, the operation is performed under local anæsthesia. Novocain $\frac{1}{2}$ per cent. with suprarenin is used and the injection is made by a combined conduction-infiltration method along the lines laid down by Braun and Schleich. As much as 300 c.cm. may be used with safety in an average adult. This is more than ample for any case, even for large bilateral herniæ in an adipose individual. The operation is practically painless, if the injection is correctly done. The dangers and annoyances of a general anæsthesia are avoided, it is frequently a great advantage to have a conscious patient, who can cough to demonstrate the sac and to test the suture line, and in my experience with a large number of cases, I have yet to see primary union interfered with on account of the injection.

The usual oblique skin incision is made. It should be sufficiently long that there is a free exposure at the medial angle. Every bleeding

point must be carefully clamped and ligated. This is especially important when local anæsthesia is used, to avoid troublesome hæmatomata. The external oblique aponeurosis is next split in such a way as to leave a liberal lower flap, and the cord with the sac is lifted out of its bed. The sac is bluntly stripped from the cord to the point where the peritoneum begins to spread and opened to see that it is empty. If necessary, adhesions between the sac and its contents are separated and excessive or diseased omentum resected. The sac is now ligated, or transfixated and ligated *as high up as possible* and amputated, and the stump is allowed to recede under the muscle. Should the hernia be of the congenital type, the testicle is lifted out of the scrotum and that part of the sac which represents the tunica vaginalis is everted around the testicle and sutured posteriorly as in the Jaboulay-Winkelmann operation for hydrocele. The subsequent formation of a hydrocele is thus prevented. The cord is next freed of superfluous fat or lipomata, and varicose veins and useless cremasteric fibres on the cord are ligated as high and as low as possible and resected. In other words, the cord is reduced to its minimal size, containing only its essential structures, the vas deferens with its vessels, the spermatic artery and veins, and the genital branch of the genitocrural nerve. In direct herniæ the sac is simply replaced, unless very large, when it may be inverted with a suture or a portion may be resected and the peritoneum closed in the usual fashion. In certain old direct herniæ, the sac and properitoneal tissues may be markedly hypertrophied. Under such conditions it is advantageous to invert the edges of the resected sac and the adjoining fibrous structures by an extra layer or two of sutures to help hold back the hernial protrusion and reduce the strain on the eventual plastic. A small oblique hernia is frequently found coexistent with a larger direct hernia. It should not be overlooked, but its sac should be searched for on the cord, lateral to the deep epigastric vessels, and properly disposed of. In right-sided hernia, unless there is some definite contraindication, I usually remove the appendix, even if this has not been the source of trouble. In the majority of cases this can easily be done through the opened sac. In some cases this is not possible owing to adhesions or high position. Then one may resort to the plan proposed by Torek, namely, an extension upward of the incision in the aponeurosis of the external oblique and an appendectomy through a typical McBurney gridiron incision. This extension, of course, is only indicated if there is a history of appendicular disease. The argument has been advanced that simultaneous appendectomy introduces the chance of infection into what should be an absolutely aseptic operation and thus increases the risk of recurrence by possibly interfering with the essential primary union. This theoretical objection is not founded on fact, as is proved by a substantial series of personal cases. If due precaution be observed in removing the appendix, the chances of infection are no greater than in a simple hernia operation without appendectomy.

RADICAL CURE OF INGUINAL HERNIA

The plastic closure is now begun. The inguinal branch of the ilio-inguinal nerve and, if in the way, the hypogastric branch of the iliohypogastric nerve are retracted so as not to be included in the suture. The cord is likewise retracted and the internal oblique muscle with its conjoined tendon is sutured in the usual fashion to Poupart's ligament under the cord. The apposition should be clean, without any interposition of fat, and if possible the muscle should be tucked under the shelving edge of the ligament. It is usually better to begin just medial to the point of emergence of the cord and progress toward the pubis. Frequently the internal ring may, with advantage, be displaced somewhat laterally by the first suture without constricting the cord. Interrupted sutures should be used and they should first be passed through the muscle and then through Poupart's ligament. They should be passed rather flatly through the muscle as it is possible to penetrate too deeply and injure the gut. A good bite of Poupart's is taken, care being observed, of course, to avoid the femoral vessels. When going through Poupart's one should attempt to pass the needle for the various sutures between different fibres to prevent tearing of the ligament. When placing the suture next to the pubic spine the needle should deliberately scrape the bone and include a small portion of Gimbernat's ligament. Four to five sutures from the internal ring to the pubic spine are usually sufficient. One or two sutures are then placed lateral to the ring as has been suggested by Scudder and Coley. The ring should close snugly about the cord, but one must not strangulate it (Fig. 1). The sutures should not be tied too tightly, but the approximation should be accurate. I do not believe that it is necessary to suture between the vas deferens and spermatic vessels as originally suggested by Torek and recently advocated again by Quain. This refinement of technic, while it may be theoretically sound, is not of great practical importance.

The next step is the suture of the upper flap of the aponeurosis of the external oblique to Poupart's, also beneath the cord, just over the previous suture line. This procedure was originally suggested by Halsted, again recommended by Andrews, Fournel, and Hackenbruch and adopted by Judd and Masson of the Mayo Clinic. It may be done with interrupted sutures or with two short continuous sutures. The aponeurosis should be sutured lateral and medial to the exit of the cord, leaving a sufficient interval at its point of emergence to avoid strangulation. Medial to the ring the suture should extend to the spine of the pubis (Fig. 2). In the average case, there is not the slightest tension on this suture line.

The lower flap of the aponeurosis of the external oblique is now split, with a straight, double blunt-pointed scissors, perpendicularly to its fibres, at a point opposite the ring. This division is extended directly up to Poupart's ligament, but not into it, and one must guard the cord with a blunt instrument to avoid nicking it. This divides the lower flap into two portions, one smaller, lateral, and one larger, medial to the point of

exit of the cord (Fig. 3). This section of the lower flap is necessary to avoid angulating the cord when the lower flap is overlapped on the upper flap beneath the cord. The smaller, lateral portion of the lower flap is now overlapped on the already sutured upper flap of the aponeurosis and held in place with several interrupted or a short continuous suture. The larger, medial portion of the lower flap is now passed beneath the cord and sewed on the upper flap of the aponeurosis in a similar manner, the suture extending as near to the pubic spine as possible. A stitch is taken at each point where the lower flap has been divided and lies on the upper flap of the aponeurosis (Fig. 4). The angles of the lateral and medial flaps should approach each other as closely as possible without constricting the cord. In some cases they can be approximated or even overlapped.

The cord is now left subcutaneous. This is really not objectionable, inasmuch as, normally, at least a portion of the cord lies in this position, and at even a more exposed place, namely, where it emerges from the external inguinal ring. Both Halsted and Ferguson in their original publications, and likewise Postempski, suggested the placing of the cord subcutaneously. They closed the defect by a single suture line, uniting aponeurosis, internal oblique muscle, conjoined tendon and Poupart's, and did not utilize the principle of imbrication. The advantages of the proposed plan are as follows: *First*, the hernial orifice itself is closed by a triple layer of tissue and all available material for the plastic repair is used. The typical Bassini suture of the internal oblique muscle and conjoined tendon to Poupart's is reinforced by a double suture line overlapping with broad apposing surfaces the aponeurosis of the external oblique *beneath* the cord. It is conceivable that, should one or even two of the suture lines give way, the third will be sufficient to prevent a recurrence if this method is practiced. *Second*, the danger of kinking and strangulation of the cord is reduced to a minimum as it is permitted to emerge perpendicularly through the abdominal wall. *Third*, should there be oozing from the cord, the hematoma, which might form, would be merely under the skin instead of submuscular or subaponeurotic.

I have been practicing this method for the past three years. I used it extensively during my service in the army, where a certain repair was particularly indicated, and where it was necessary to have the strongest support with the least danger of recurrence. I have personally operated on some 200 cases by this method. These cases include almost every conceivable type of inguinal hernia. As yet I have seen no recurrences in the cases which I have been able to follow up. I have never observed any difficulties from the subcutaneous placing of the cord, and regard the objections that might be offered against this feature, such as undue sensitiveness or danger of exposure to trauma, as merely unwarranted prejudice. The method is particularly serviceable in direct and recurrent herniæ, especially larger and difficult ones, in sliding herniæ, and in

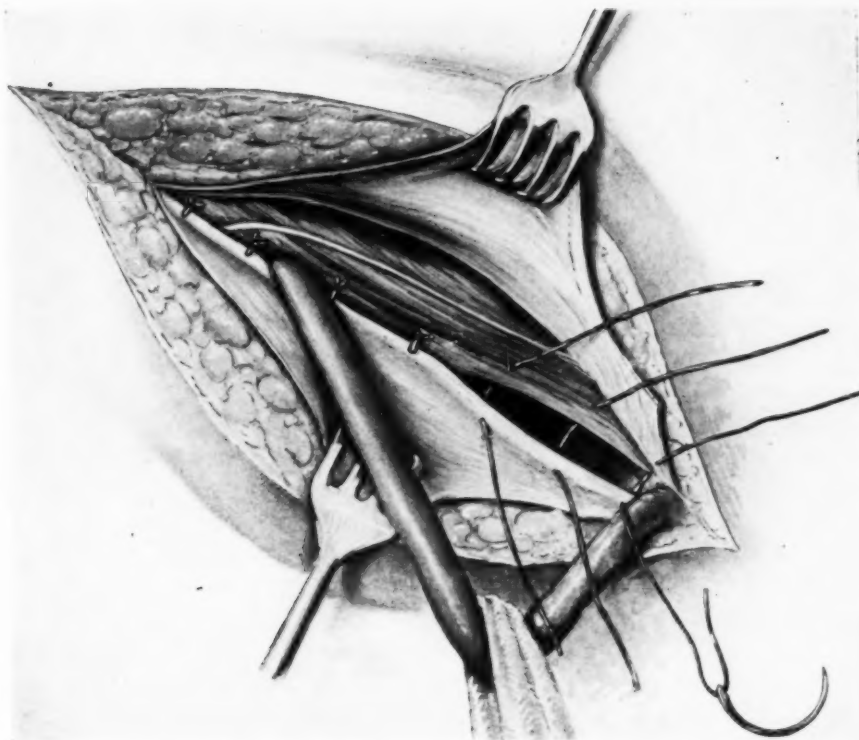


FIG. 1.—Suture of the internal oblique muscle and conjoined tendon to Poupart's ligament beneath the cord. The muscle is tucked under the ligament and two sutures are placed lateral to the exit of the cord. The inguinal branch of the ilio-inguinal nerve emerges between the sutures.

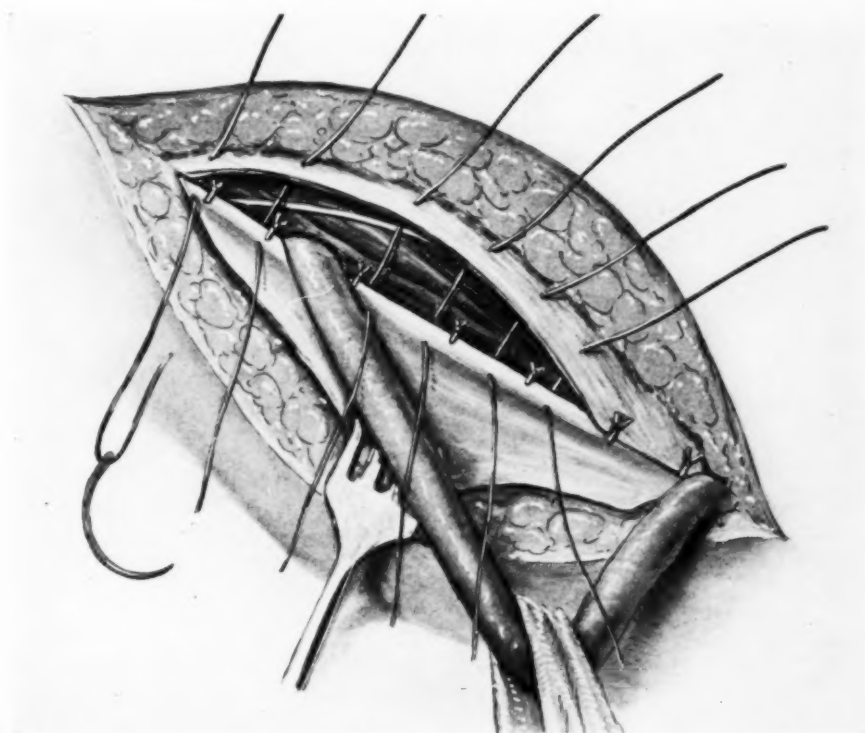


FIG. 2.—Suture of the upper flap of the aponeurosis of the external oblique to Poupart's ligament beneath the cord and over the previous suture line of the internal oblique muscle and conjoined tendon to Poupart's ligament, which has been completed.

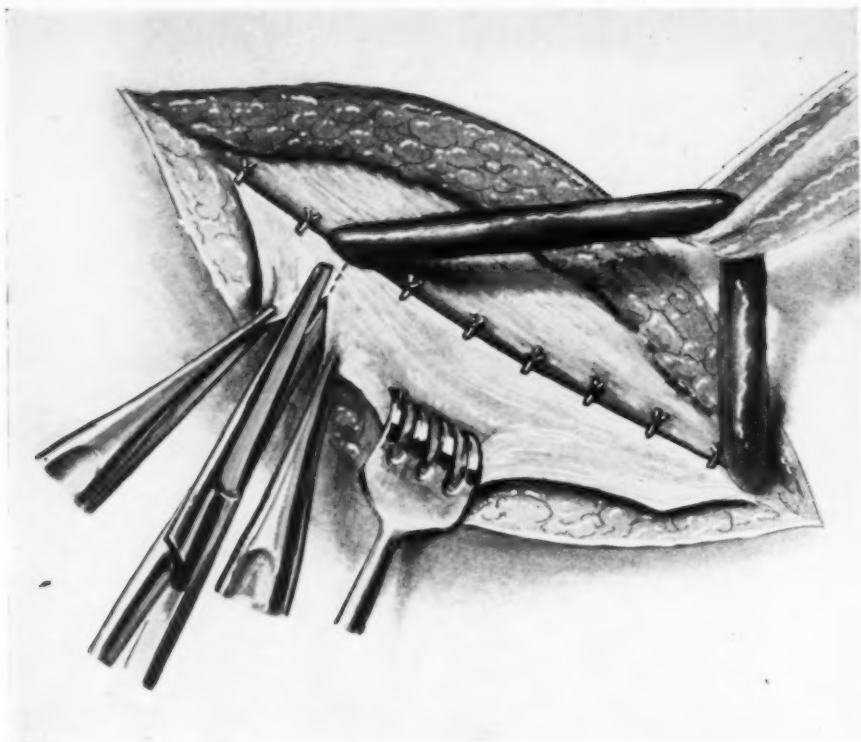


FIG. 3.—The suture of the upper flap of the aponeurosis of the external oblique to Poupart's ligament has been completed, medial and lateral, to the exit of the cord. Splitting of the lower flap of the aponeurosis of the external oblique, perpendicularly to its fibres at a point opposite the ring. The lower flap is now divided into a smaller lateral and larger medial portion.

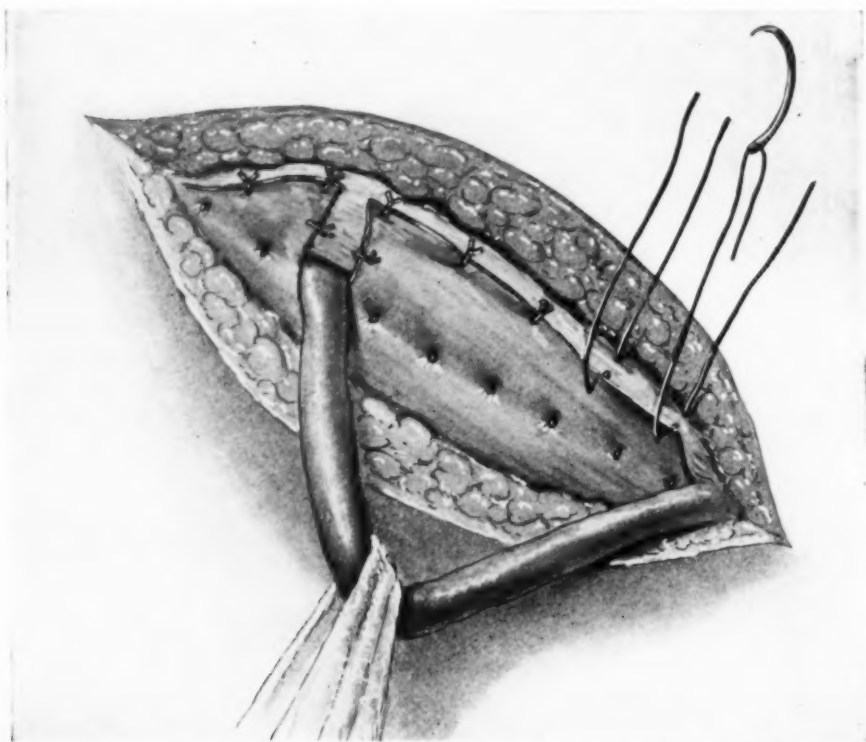


FIG. 4.—Overlapping and suture of the two portions of the lower flap on the already sutured upper flap of the aponeurosis of the external oblique. The larger, medial portion is passed beneath the cord, permitting the cord to emerge subcutaneously between the two divisions of the lower flap. A stitch is taken at each point where the lower flap has been divided and lies on the upper flap.

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cases where the development of the internal oblique muscle and conjoined tendon is poor or where Poupart's ligament is thin or tears easily. These latter conditions are especially found in elderly patients, who have had their herniæ for many years and have worn trusses. It was just in these difficult cases that the insufficiency of the single suture line between the internal oblique and conjoined tendon and Poupart's was noted, and, as a result of this observation, the above described technic was developed to overcome its defects to the maximum degree. Fortunately, in these cases in which the reinforcement of the Bassini suture is most needed, the external oblique aponeurosis is frequently found to be a particularly useful structure for the plastic, dense and hypertrophic. Since the adoption of this method I have found the formation of a flap from the rectus muscle or anterior rectus sheath, as advocated by Wölfler, Bloodgood, Halsted, Davis, Downes, Lusk, and others, unnecessary, even in the most unfavorable cases. Orchidectomy has never been required. I feel that, if the proposed plan of operation is superior for the complicated cases, it should be used in all cases, even in the simplest ones. As Masson states, "a technic which is preferable in difficult cases is also preferable in simple cases." A radical repair cannot be too radical or a certain cure too certain. In the female a similar procedure of triple suture line and overlapping the aponeurosis is practiced, omitting, of course, the splitting of the lower flap, which the absence of the cord renders unnecessary. The round ligament is fixed by including it in one or two of the sutures between the internal oblique and conjoined tendon and Poupart's. In cases of undescended testis the method described by Davison is preferred.

As suture material I prefer No. 2 or No. 3 chromicized catgut for the deep, internal oblique, conjoined tendon suture, and No. 1 or No. 2 chromicized catgut for the aponeurotic sutures. In children the finer material should be used. I do not believe that the use of non-absorbable sutures, such as silver wire, silk, or linen, or even of very slowly absorbable material, such as kangaroo tendon, is to be recommended, nor do I think that mattress or other elaborate or complicated suture methods are necessary. The success of the operation, obviously, does not depend upon the strength and permanency of the suture material nor upon the type of the stitch itself, but upon the successful union of the structures to one another. Further, the leaving of foreign bodies in the tissues is generally to be avoided, as these tend to produce irritation, favor infection, and may lead to eventual sinus formation and the necessity for their removal. I favor the simple absorbable suture, but use it interrupted, so that in case of infection there is some chance that at least part of the suture line may hold.

In recurrent cases or large herniæ where there has been considerable oozing a small, split rubber tube drain should be placed subcutaneously at the lower angle of the incision for the purpose of relieving the serous accumulation which is liable to occur. This may be removed after a few

days. The skin should be sutured with interrupted silkworm gut. One point about the dressing, which should be a *double spica*, is that the scrotum should be exposed so that the condition of the testicles can be observed. One can then appreciate if there is any strangulation of the cord. The possible displacement of the testicle on the abdomen is another accident which can also be avoided by this manœuvre. This can occur with disastrous results to that organ if the scrotum is included in the bandage. To prevent undue congestion of the testicles the scrotum should lie on an adhesive plaster bridge. The average patient may be allowed up in from ten to twelve days after operation. In double herniæ, in large, difficult or direct herniæ, the patient should be kept in bed a few days longer. No heavy work should be permitted for at least six weeks, and under no circumstances should a truss be applied.

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THE UTILIZATION OF THE EXTERNAL OBLIQUE APONEUROSIS IN INGUINAL HERNIA WITH MUSCLE DEFICIENCY

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SINCE 1912¹ I have practiced and urged the extra fortification of the inner half of the inguinal canal in those cases of hernia where our muscular structure (the so-called conjoined tendon), principally the internal oblique muscle, was weak, attenuated or deficient. It is not enough to pull down and suture the unopened rectus sheath—there is too much tension. Firmer and less stretchable union is secured by living viable united muscle to Poupart's ligament. Furthermore, the union of the rectus sheath (unopened) to Poupart's ligament is interfered with by cellular tissue covering the sheath and is in no way comparable to the apposition of clean muscle to cleaned aponeurosis. The wide opening of the rectus sheath allows the muscle to be drawn down without tension and sutured cleanly to Poupart's ligament by four or more sutures.

The problem of hernial repair is greatly simplified if we take into consideration the resources of our anatomy in this region. Our operative procedure is not at all complicated, consuming but possibly ten or fifteen minutes in addition to our regular Bassimi type repair. The cases calling for further elaboration or additions to the Bassimi operation are greatly in the minority fortunately but are a respectable percentage. It is difficult to see why rectus transposition, aponeurotic transposition of rectus sheath or external oblique should not be more generally employed.

Surgery has very far from reached the limit of its anatomical resources alone and few, if any, of our present-day procedures are incapable of improvement. Even such a one as Bassimi's operation for hernia, founded upon correct, sound anatomical and physiological principles, may with advantage at times be added to where we are obliged to. We should suit the operation to the case and anatomical condition presenting rather than force the case into a stereotyped operative procedure however good it may be and applicable to 90 per cent. of the cases presenting.

There is another procedure I wish to speak of here and which is too little used as an additional fortification: the suture of the inner half of the external oblique aponeurosis to Poupart's ligament after the suture of the internal oblique and conjoined tendon and the overlapping of this internal half by the external half. This has been very useful both in the cases of moderate muscular deficiency of the internal half of the inguinal canal and in the very bad cases for repair where we find our-

¹ ANNALS OF SURGERY, October, 1913; April, 1918.

selves obliged to use every resource, such as rectus transposition, in addition. The illustrations give one scheme for such utilization of the oblique aponeurosis, or it may not be split and only overlapped to the site of the transplanted cord.

Transplantation of the cord I believe an essential part of the operation for hernia, and I thought the question settled upon that point. Non-transplantation leaves an opening at the weak inner angle and excision of the cord veins may result in testicular atrophy as is well known. The whole inguinal canal should be obliterated and by the apposition of muscle to Poupart's ligament. I do not feel that the problem of the cure of the various types of inguinal hernia is settled, but I do feel that the various procedures which the anatomy of the inguinal region makes possible should be more extensively employed as adjuvant measures to the operation which bears Bassini's name.

The position of the patient post-operative is of importance. Moderate elevation of the trunk and thighs, so easily accomplished with the Gatch bed, relaxes rectus tension as well as aponeurotic, and eighteen months' experience with it has shown that it is not only comfortable, but gives a physiological rest.

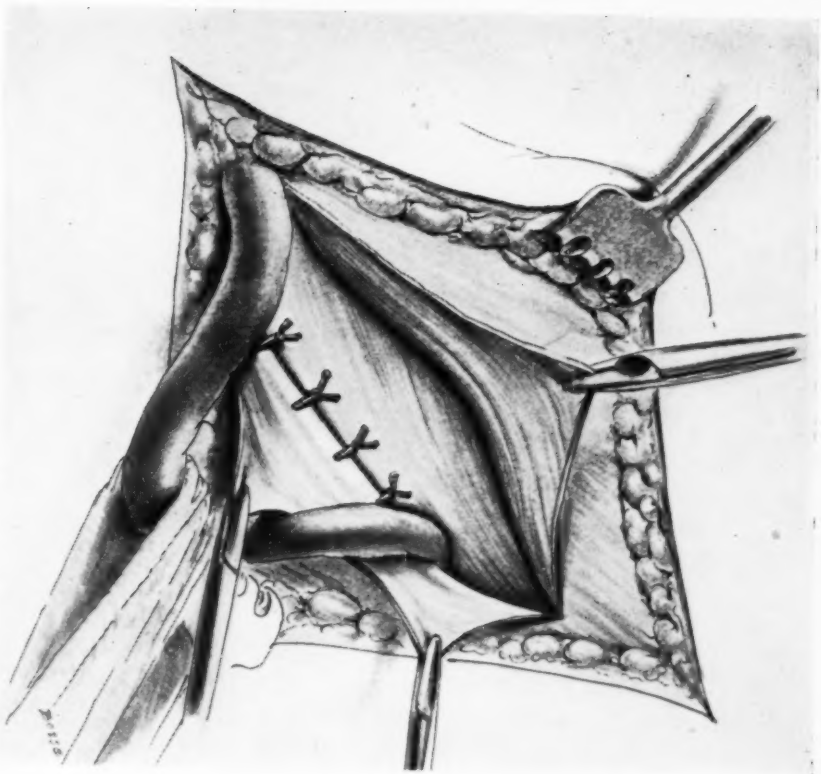


FIG. 1.—Internal oblique and conjoint tendon sutured to Poupart's ligament.

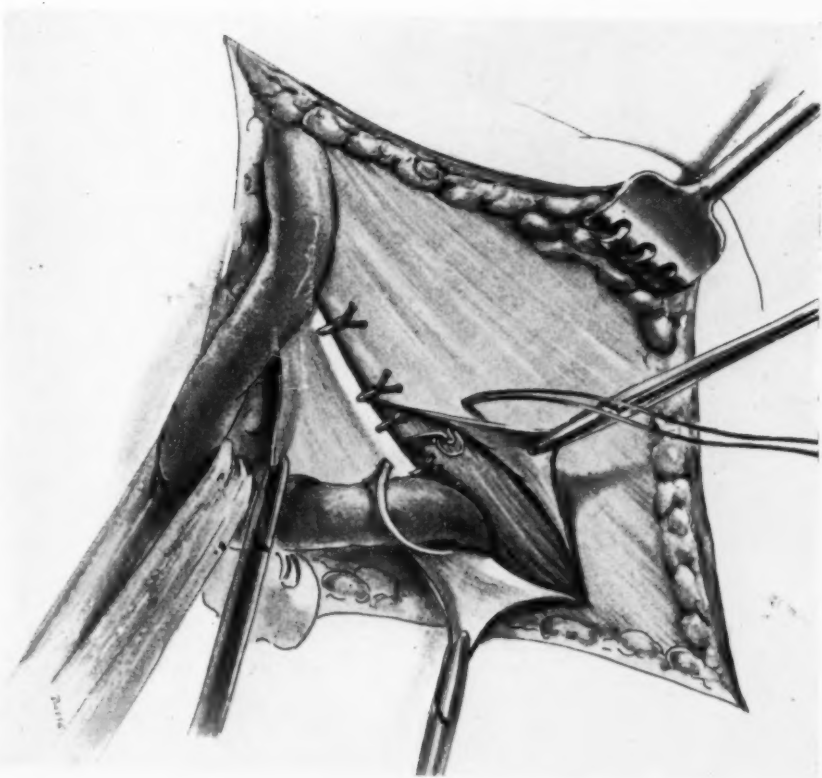


FIG. 2.—Suturing inner half of external oblique aponeurosis to Poupart's over weak internal oblique and conjoint tendon.

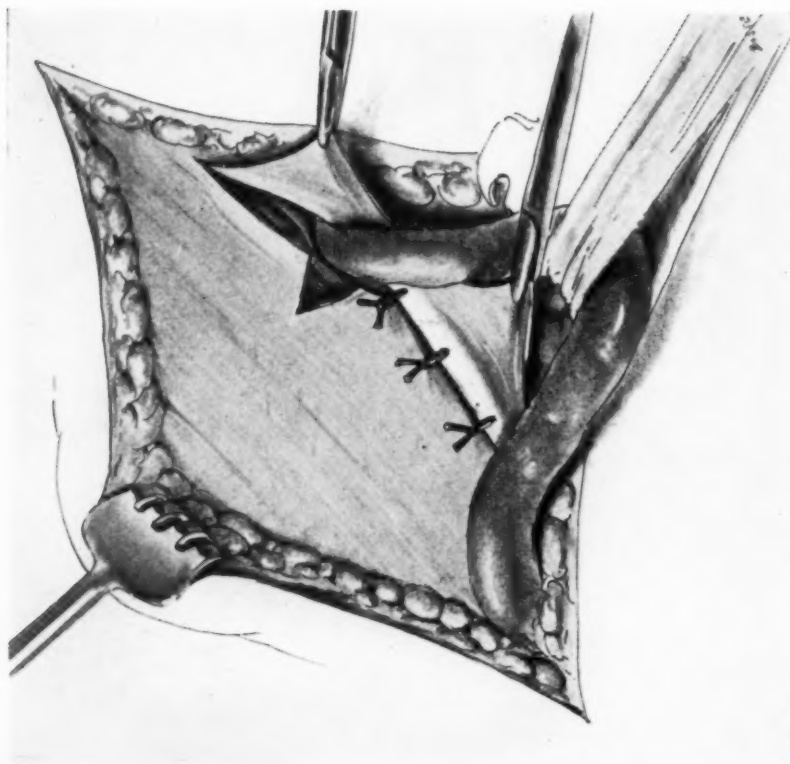


FIG. 3.—Inner half of external oblique aponeurosis may be notched for cord or sutured only to cord,

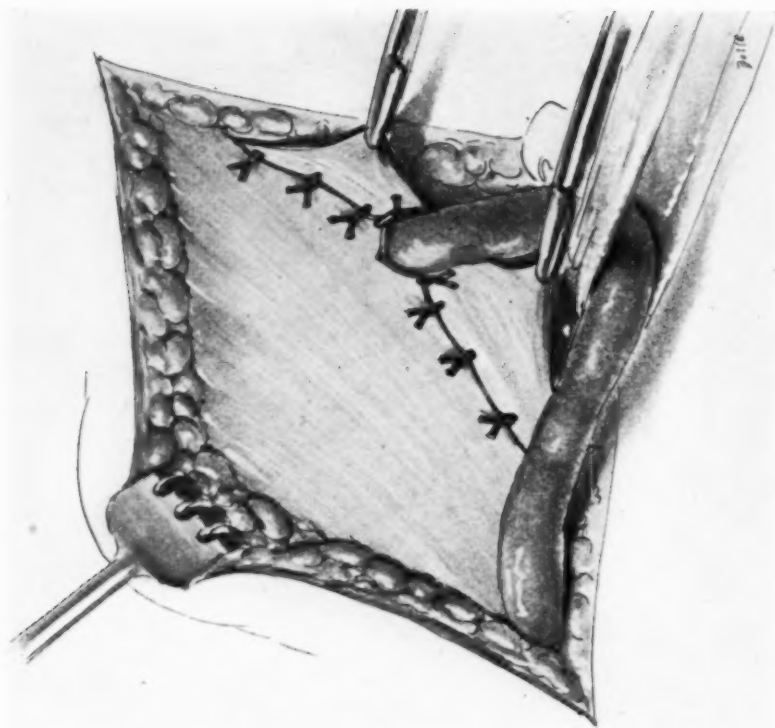


FIG. 4.—Completion of suture of the inner half of the external oblique aponeurosis to Poupart's,

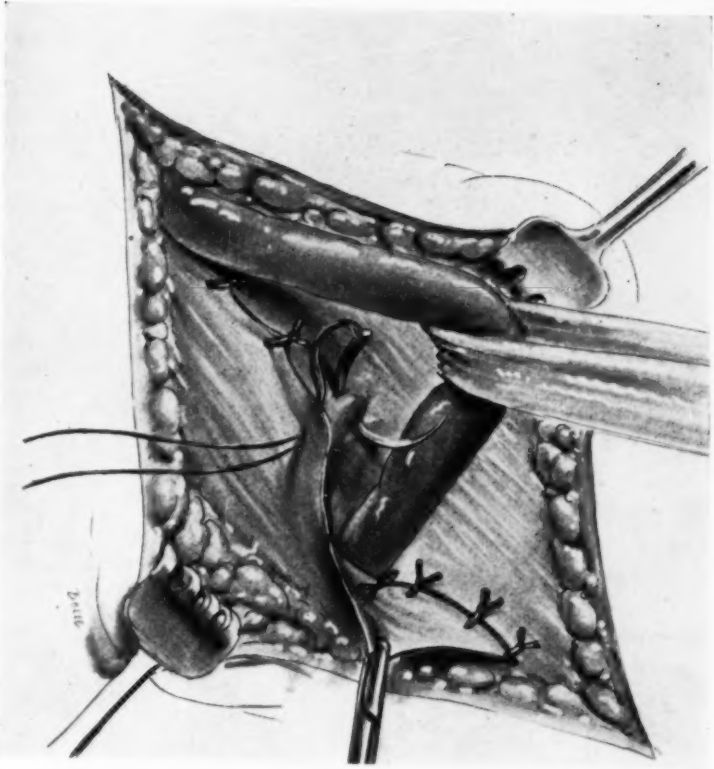


FIG. 5.—The outer half of the external oblique aponeurosis lapping suture line and folded over inner half secured by interrupted sutures.

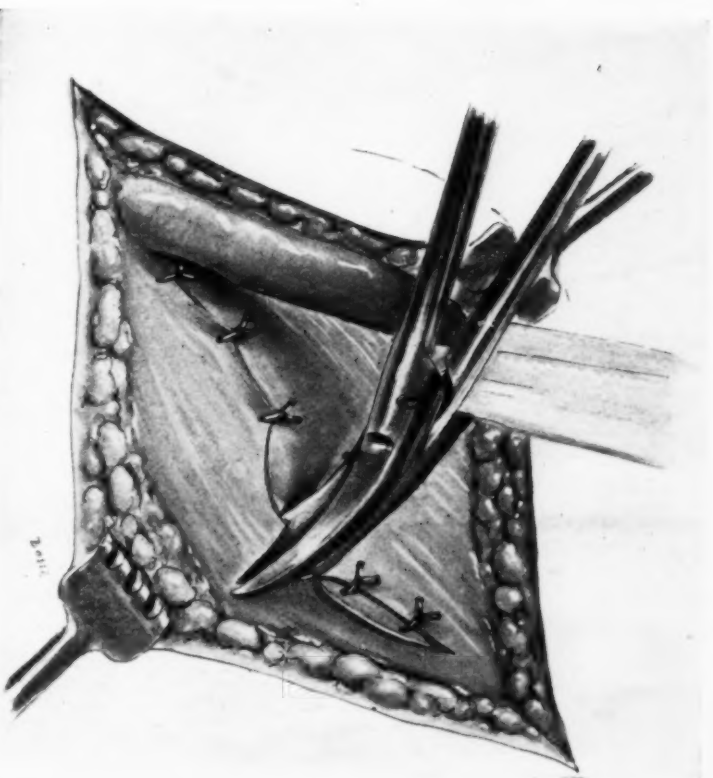


FIG. 6.—The outer half may also be notched to surround transplanted corl or may be sutured only to site of corl.

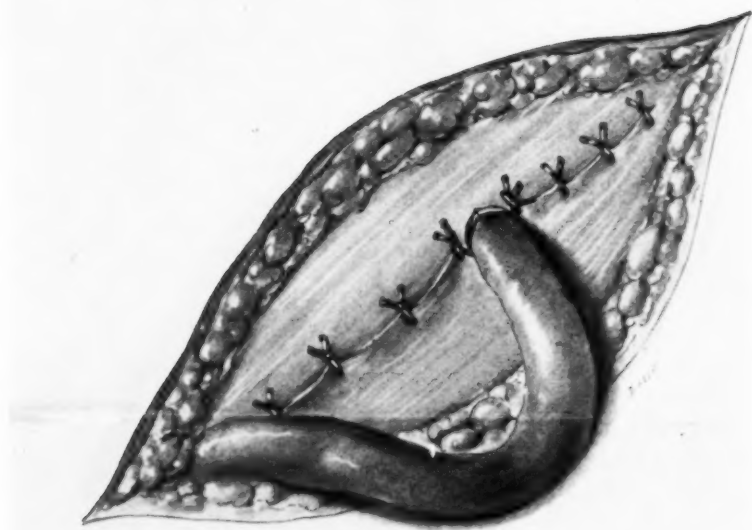


FIG. 7.—Completion of overlapping.

MULTIPLE FIBROIDS IN THE MALE PELVIS

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Most text-books on surgery refer to the possible occurrence of fibroids or other benign tumors in the retroperitoneal space, but it seems that their occurrence is of sufficient rarity to warrant the report of the following case in some detail.

From a surgical point of view, the case also brings up a point of considerable importance. It is the misfortune of most surgeons to occasionally meet with sarcoma of the retroperitoneal space or pelvis, and it so frequently happens that upon exploratory laparotomy it is found that the palpable, partly movable tumor is only an excrescence on a very much larger and inoperable mass, that the surgeon is apt to become discouraged with such cases and consider all such tumors as inoperable. The patient whose case is being described, had passed through several hospitals; one surgeon without operating had pronounced it an inoperable malignant growth, and another had opened the abdomen and closed it with a diagnosis of inoperable sarcoma. It seems worth while, therefore, to accent the fact that such tumors may be benign and removable.

The patient (F. W., Reg. No. 45250), a well-developed male, aged thirty-three years, occupation harnessmaker, family history negative, previous personal history negative, in March, 1919, began having pains in left thigh and calf of left leg. In April, 1919, was admitted to a hospital in France, with œdema of left leg and thigh; and in May a tumor was discovered in the lower left quadrant of the abdomen, when he was returned to the United States and admitted to a base hospital. Diagnosis was made of inoperable malignant growth. In August patient was examined by another surgeon, and exploratory laparotomy done. Wound was closed and diagnosis of inoperable sarcoma was made. Was admitted to General Hospital No. 28 on account of œdema of left leg and thigh and large abdominal tumor. His appearance did not suggest malignant disease, there being little anæmia and no cachexia. General physical examination negative except for a large nodular mass completely filling the left lower quadrant of the abdomen to level of umbilicus. Superficial veins over this area much distended, marked œdema of left leg and thigh. Mass very slightly movable. X-ray examination with opaque meal showed the sigmoid on the right side of the abdomen and the meal delayed in the descending colon for ninety-six hours. Wassermann negative.

Operation.—Incision through left rectus; the tumor found to be

retroperitoneal but firmly adherent to the anterior abdominal wall at site of previous operation. After separating these adhesions it is found that the tumor has its attachments in the pelvis. The sigmoid is in the right iliac fossa, the common iliac artery and ureter run through the right side of the tumor and are displaced inward to the midline. A large vessel, either external iliac or greatly enlarged deep epigastric, runs through the lower end of the tumor near the pubis. It is found that the mass can be separated by the hand into five distinct parts. These are firmly attached to the periosteum or deep pelvic fascia. One is attached to the left border of the sacrum down to the coccyx, one in the hollow of the ilium, and one under the pubis. The mass fills the concavity of the sacrum and has pushed its way under the pubic bones on the left side. The two smallest of the tumors have no definite attachment to the bone. The capsules of the tumors contain large veins, but as the attachments of the tumors are divided the tumors themselves are found to be not very vascular. The five tumors removed separately. Patient made an uneventful recovery. Œdema of leg and thigh had disappeared in four or five days.

The laboratory report follows:

Specimen from F. W., Private, Co. B, 355th Infantry, Ward 55. This specimen comprises five separate tumors, the largest of which is 12 x 7 cm., and the smallest is 4 x 3 cm. They are encapsulated, tuberous, firm, and pinkish white in color. On section they are white, glistening, and very fibrous. There is a cyst the size of a cherry in the centre of the largest and the second largest. The smallest tumor is darker in color than the others, less firm, and on section is flesh-like. The total weight is 653 grams.

Microscopical Examination.—Many sections taken from different areas in the smallest tumor were studied to determine the presence or absence of sarcomatous degeneration in this fibroid. While some sections show a much greater preponderance of cells than others, it is believed that this tumor has not become sarcomatous.

Diagnosis.—The four largest tumors are hard fibromas; the smallest, a soft fibroma. Laboratory examination by Major J. F. Hammond, M. C.

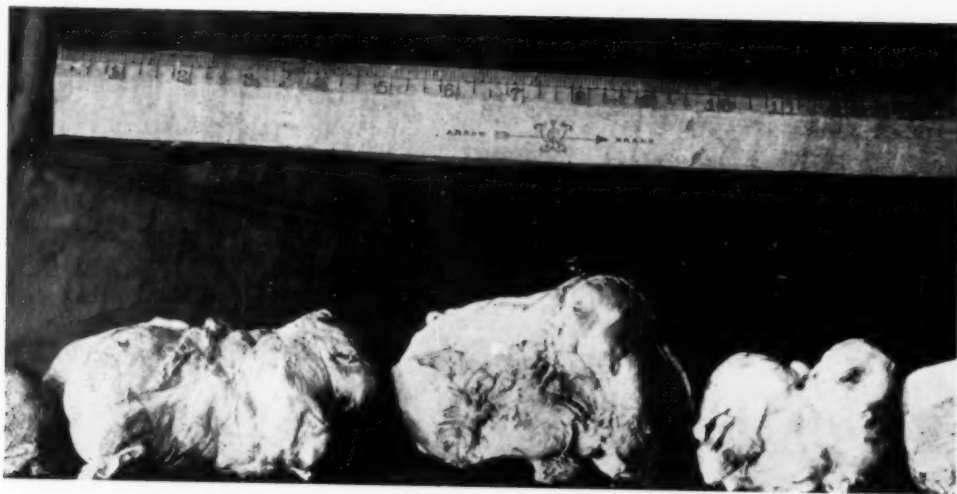
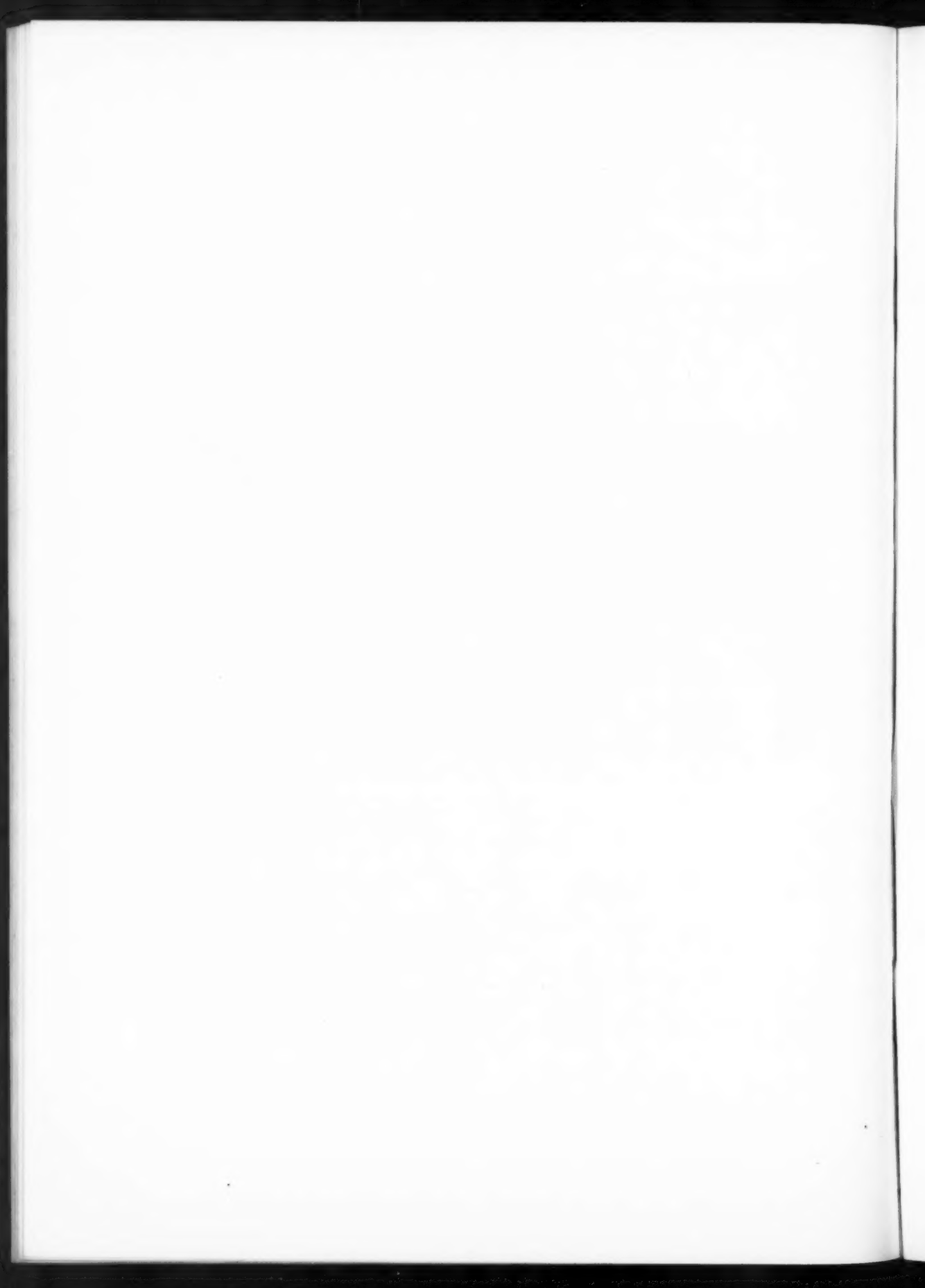


FIG. 1.—Multiple fibroids of male pelvis. Case of P. W., No. 45250, General Hospital No. 28.



INTESTINAL OBSTRUCTION DUE TO THE ASCARIS LUMBRICOIDES

By FRED C. WATSON, M.D.

OF BOCAS DEL TORO, PANAMA

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ASCARIASIS, or infestation with the round or eel-worm, *Ascaris lumbricoides*, is one of the most common invasions of man by animal parasites. It is found in practically all parts of the world and is especially prevalent in tropical and subtropical countries. It is most frequently encountered during childhood, although it may occur at any age. The most common host of the ascaris is man. No intermediate host is required. Its life history begins immediately after the eggs have been ingested. Its normal habitat is the small intestine. Usually only a few worms are present in the milder infections, while in the heavier infections hundreds of worms may be present. Ordinarily no great harm results from the presence of a few ascarides. The symptoms produced vary greatly. In a majority of cases there are nervousness, irritability, colicky pains in the abdomen, disturbed sleep, picking at the nose, grinding of the teeth, and a moderate degree of anæmia. In young children, convulsions are not uncommon. The migrations of the parasite have long been recognized and present a very dangerous aspect of ascariasis. Cases are on record in which the parasite has been found in the gall-bladder and biliary ducts, the liver, the pancreatic duct and the urinary passages. Intestinal ulcers have been perforated and it is claimed by some that even the healthy bowel has been perforated by them. Fatal asphyxia has been known to result from their entrance into the larynx or into the trachea and lung. Gangrene of the lung has been noted. Recently Adeodato¹ reported the finding of a dead ascaris in a tubal cyst. In exceptional cases, a mass of ascarides may become matted together in the right iliac region and simulate appendicitis, with abscess formation, as in the case reported by Kidd.² Or intestinal obstruction may be produced. A perusal of comparatively recent literature leads one to suspect that the latter condition is not as uncommon as it is generally believed.

Perrett and Simon, in 1917, quoted by Levy,³ collected the reports of fourteen cases of intestinal obstruction due to the ascaris and added a case of their own.

Isolated cases have since been reported by Heiser,⁴ Levy,³ Aperlo,⁵ and Katzareff.⁶

During the past year the writer has operated on one case and assisted in the operation of another case of intestinal obstruction due to an impacted mass of ascarides in the ileum. Both cases occurred in the negro

race. In the first case, that of a male, aged twenty-five years, over 58 worms were present. In the second case, that of a female, aged seven years, over 25 worms were present. These cases are herewith reported more in detail.

CASE I.—A. Reed, male, negro, Jamaican, aged twenty-five years, occupation laborer, was admitted to the hospital April 18, 1919.

Past and family histories were unimportant.

Present History.—Three days ago first felt colicky pains in the abdomen, generalized at first, later becoming localized in the right lower quadrant. The pains gradually increased in severity. There was nausea but no vomiting. The bowels had not moved since the onset of the pains. Examination revealed moderate rigidity of the right rectus muscle; moderate abdominal distention and a tender mass in the right iliac region the size of an orange. The temperature was 97° F., pulse, 50; respiration, 24. There was a leucocytosis of 8000.

Operation (Doctor Watson).—Right rectus incision. Straw-colored fluid escaped when the peritoneal cavity was opened. The lower end of the ileum was markedly reddened and œdematous. About six or eight inches from the cæcum, the ileum was completely obstructed by a mass of ascarides. As it was found impossible to dislodge the mass of worms, an incision was made in the long axis of the bowel opposite to the mesentery. Fifty-eight ascarides, alive and squirming, were removed. Quite a few worms crawled along the lumen of the bowel out of reach of the forceps and were not removed on account of the danger of contamination. A small cigarette drain was inserted and the abdomen was closed.

Post-operative Course.—As the patient was recovering from the anæsthetic (ether) three ascarides were vomited. Four grains each of calomel and santonin were administered on the third day, when several worms were expelled per rectum. The cigarette drain was removed at the end of forty-eight hours. The wound healed promptly. An examination of the stool several days after the administration of the calomel and santonin was negative for ova. The patient was discharged from the hospital May 7th.

CASE II.—D. H., female, negro, Panamanian, aged seven years, was first seen January 8, 1920, in the Out Patient's Department of the hospital, at which time the mother stated that the child was very nervous, cross, irritable, and at times complained of griping pains in the abdomen, particularly in the region of the navel. The appetite was poor. Grinding of the teeth was noticed when the child was asleep.

Examination showed an anæmic and emaciated child. The abdomen was quite distended with gas. The spleen could be felt 2 inches below the left costal margin. There was no tenderness nor rigidity. The temperature, pulse, and respiration were normal. An examination of the blood was negative for malarial parasites. There was, however, a moderate reduction of the hæmoglobin.

Examination of the fæces showed the presence of a large number

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of the ova of *Ascaris lumbricoides*, a few *Anchylostoma* and *Trichocephalus dispar*. Two grains each of calomel and santonin were administered and the mother stated that many round worms were expelled. The child was not seen again until the morning of January 16, 1920, when the mother brought her to the hospital. At this time the child was suffering severe pain in the abdomen, most marked in the right iliac region. There was tenderness and rigidity of the right rectus muscle and a movable mass the size of the fist could be felt just to the right and a little above the umbilicus. The right leg and thigh were flexed on the abdomen. The temperature was 100° F., pulse, 130; respiration, 40. The bowels had not moved for two days. The diagnosis was an appendix abscess or an intestinal obstruction due to the *Ascaris lumbricoides*.

Operation (Dr. P. H. Desnoes).—Right rectus incision. About eighteen inches from the cæcum there was a reddened and congested section of the ileum which was tightly packed with ascarides. An attempt was made to dislodge the mass of worms. This proved unsuccessful. An incision was then made along the long axis of the bowel opposite to the mesentery and twenty-five ascarides were removed. The appendix was normal. The abdomen was closed in the usual manner without drainage.

Post-operative Course.—On the third day calomel and santonin were repeated and several ascarides were passed. One week later, oil of chenopodium was administered on account of the anchylostomiasis. The child is now well and strong.

N. B.—I wish to acknowledge permission from Dr. W. E. Deeks, General Manager, Medical Department, United Fruit Co., to publish this paper.

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THE PORTABLE SUSPENSION FRAME EMPLOYED IN THE TREATMENT OF THE WOUNDED DURING THE EUROPEAN WAR*

(ERRONEOUSLY CALLED THE BALKAN FRAME)

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ON assuming charge at Hospital B, American Ambulance, Juilly, Seine et Marne, in February, 1915, we were immediately confronted with the practical difficulties of dressing complicated compound fractures of the extremities. From the standpoint of the surgeon these dressings were

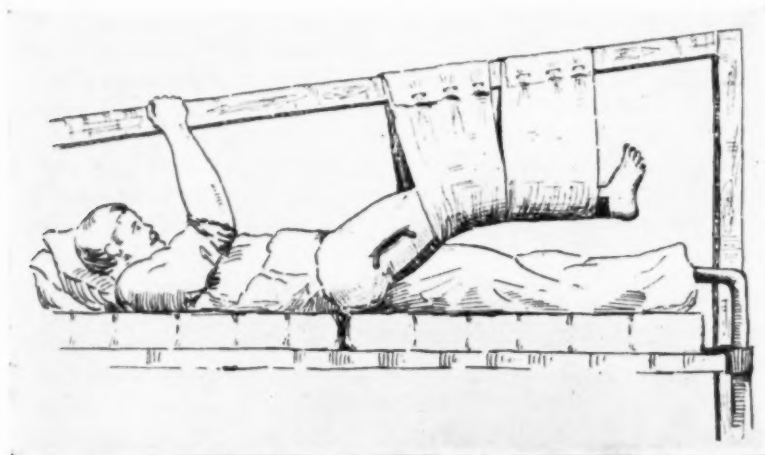


FIG. 1.—The Balkan frame as depicted by Hull. Note that this crude arrangement bears no resemblance to the author's suspension frame.

time-consuming, difficult, and unsatisfactory; to the patient they were long-drawn-out ordeals of pain. With the limited personnel at our disposal it was obvious that we must evolve a more satisfactory method of handling these cases. At this time we were receiving our wounded by ambulance direct from the French field hospitals.

It is difficult for those who did not serve in the beginning of the war to visualize the problems which confronted the military surgeon. The surgical procedures were in a state of evolution; there was no such standardization as that attained in the latter years of the war. A trial of the methods in vogue was so unsatisfactory that it was determined to abandon them and develop a suspension traction technic for the treatment of complicated compound fractures. The most popular method of suspension was by the Balkan frame. This was a crude contrivance whereby

* Read before the New York Surgical Society, March 10, 1920.

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the fractured limb was suspended in a sheet or blanket from a single ridge pole. We found this method unsatisfactory, inefficient, and clumsy. Other methods were tried, but a satisfactory solution was not obtained until the portable, overhead suspension frame was developed. During the past war this frame was incorrectly called the Balkan frame. A glance at Fig. 1, taken from Hull,¹ and Fig. 2 from Crile² will show that the author's frame bears no resemblance to the real Balkan frame. The original frame was called the Whitney-Juilly frame, for Mrs. Harry Payne Whitney, who so generously equipped and financed the hospital. The frame was first put into use at Juilly, in February, 1915. It proved such a success that it was adopted throughout the hospital. The car-

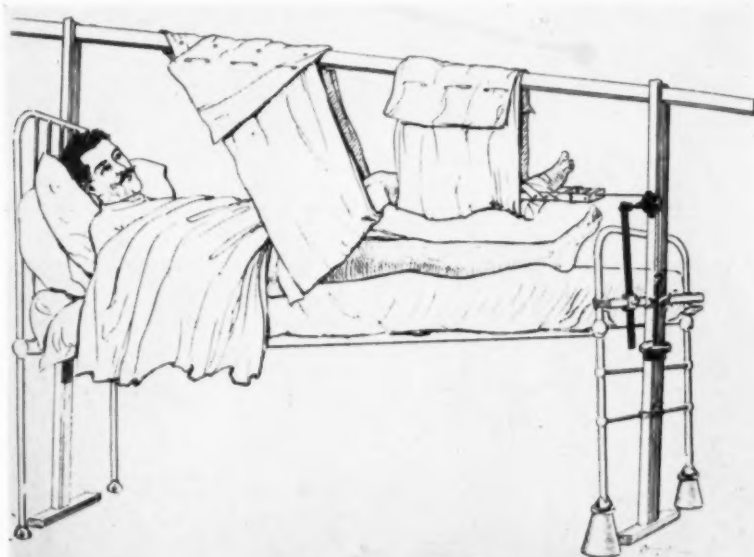


FIG. 2.—Balkan splint as used at the American Ambulance, Neuilly-sur-Seine, Paris, France (Crile).

penry work was done by Mr. Mills, one of our volunteer ambulance drivers. A model frame was given to Doctor Blake, who readily recognized its possibilities and adopted it as the standard for his wards in the American Ambulance. In March, 1915, the author demonstrated this frame to Inspector General Chevasse, of the French Army, and Colonel Route, of the 6th French Army. Pictures of this frame were shown before the Quiz Medical Society in May, 1915; and before the Surgical Section of the Academy of Medicine in the spring of 1915.

The aim was to produce a simple portable frame which could be quickly and easily erected, that would be adaptable to different types of beds, and that would stand on any kind of floor. The frame is constructed of white pine, $2\frac{1}{2}$ by $\frac{7}{8}$ inches, and consists of two quadrilateral trestles (Fig. 3) united by one or more longitudinal bars. Each trestle is composed of two parallel uprights, $6\frac{1}{2}$ feet in length, united above by a

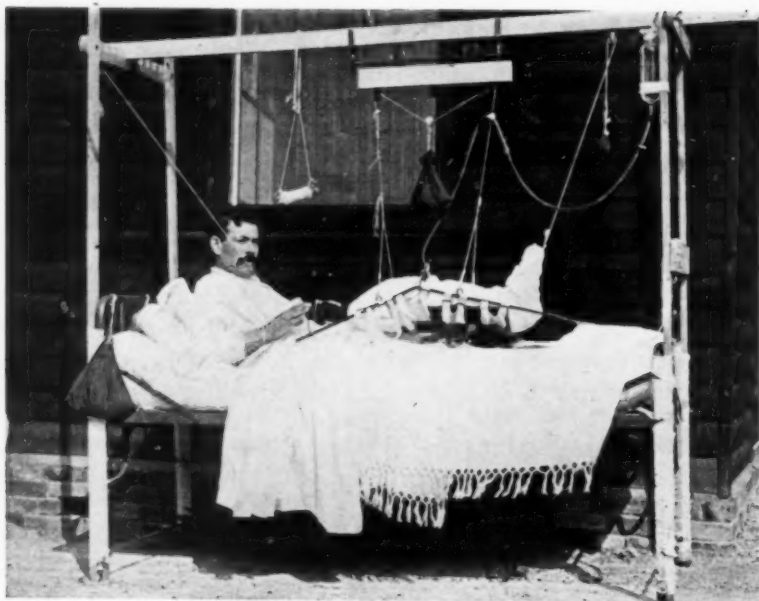


FIG. 3.—Author's frame, showing the balanced suspension treatment with method of conveying Dakin's solution to the distributing tubes. It is comfortable and greatly simplifies the dressing.



FIG. 4.—Frame collapsed, showing portability.

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notched cross-bar 3 feet 3 inches long. The cross-bars are secured to the uprights by a bolt and screw nut. The trestles are attached to the legs of the bed by bandages. A second adjustable cross-bar is placed on the trestle at the foot of the bed; this cross piece is used for the attachment of the traction pulleys. The head and foot trestles are bound together by one or two overhead carrying bars, 8 feet 8 inches long. To these are attached the suspension pulleys and the hand grasps. This frame can be made by any one having the slightest knowledge of carpentry.



FIG. 5.—Frame opened ready to be fastened to feet of bed with bandages. Shows ease of erection. This is the trestle that goes at the foot of the bed and carries the extra cross piece to which are attached the pulleys for traction. The trestle for the head of the bed has only the upper cross piece.

The original frame did not have the wooden trolley as depicted in Fig. 3, but had an iron bar and movable pulleys. The wooden trolley was added later by Doctor Blake. This trolley was not included in the equipment issued to our forces. The trolley, though not a necessity, is an aid in making the patient comfortable, and it allows more freedom of movement in bed. The frame issued to our forces differs from the original in two minor points. The uprights in the A. E. F. frame were not parallel, but were narrower at the top. This was a practical disadvantage, because it required an extra cross piece at the head of the bed,

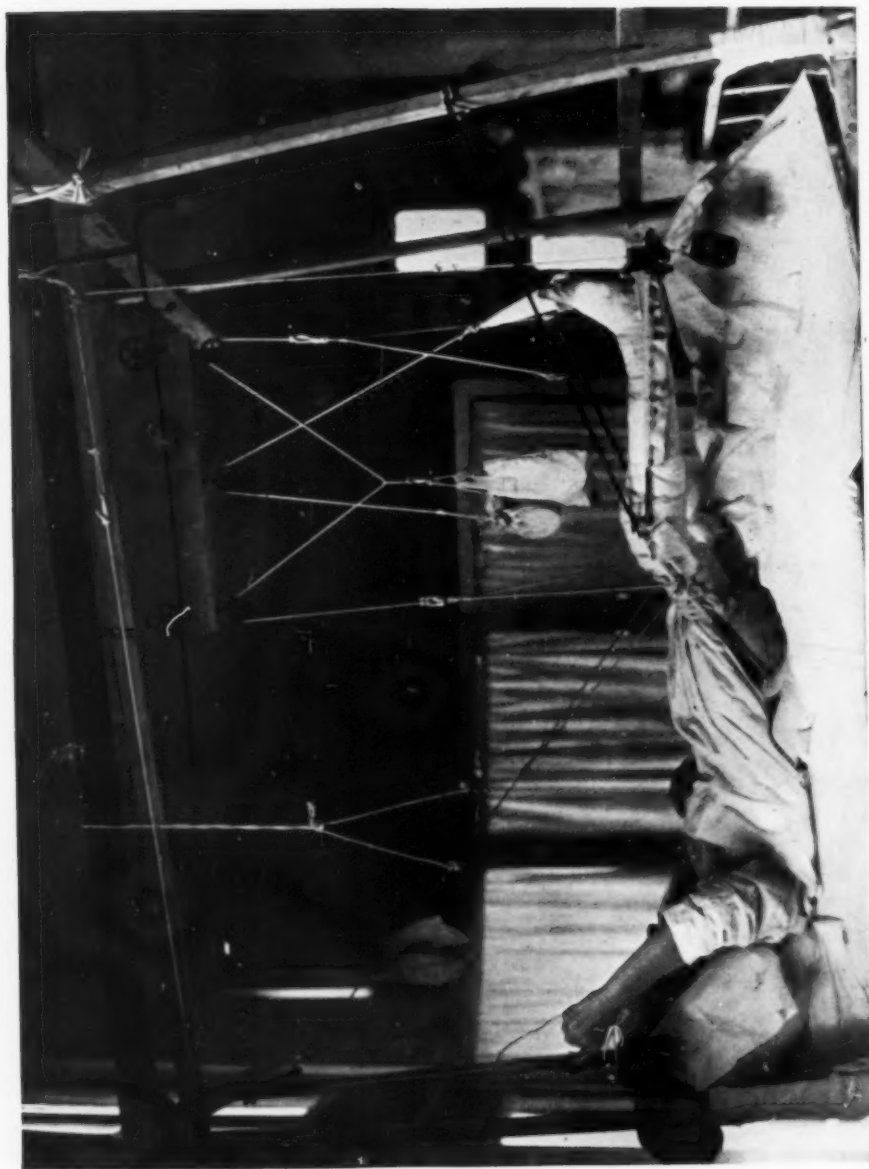


FIG. 6.—Intertrochanteric fracture of the femur in a patient, aged eighty-three years. Treated by the balanced suspension and traction method. Splint (Thomas) with hinged auxiliary for exercising the knee-joint. Traction by adhesive bands and divided pulley and weight extension. The patient is seen grasping one of the divisions of the extension. The other weight is seen close to the foot piece of the hinged auxiliary splint. By pulling on the weights at the head of the bed the patient can exercise the leg at the knee. (See Figs. 7 and 8.) The patient obtained a firm bony union without shortening, and left the hospital walking on a caliper splint. (See Fig. 9.)

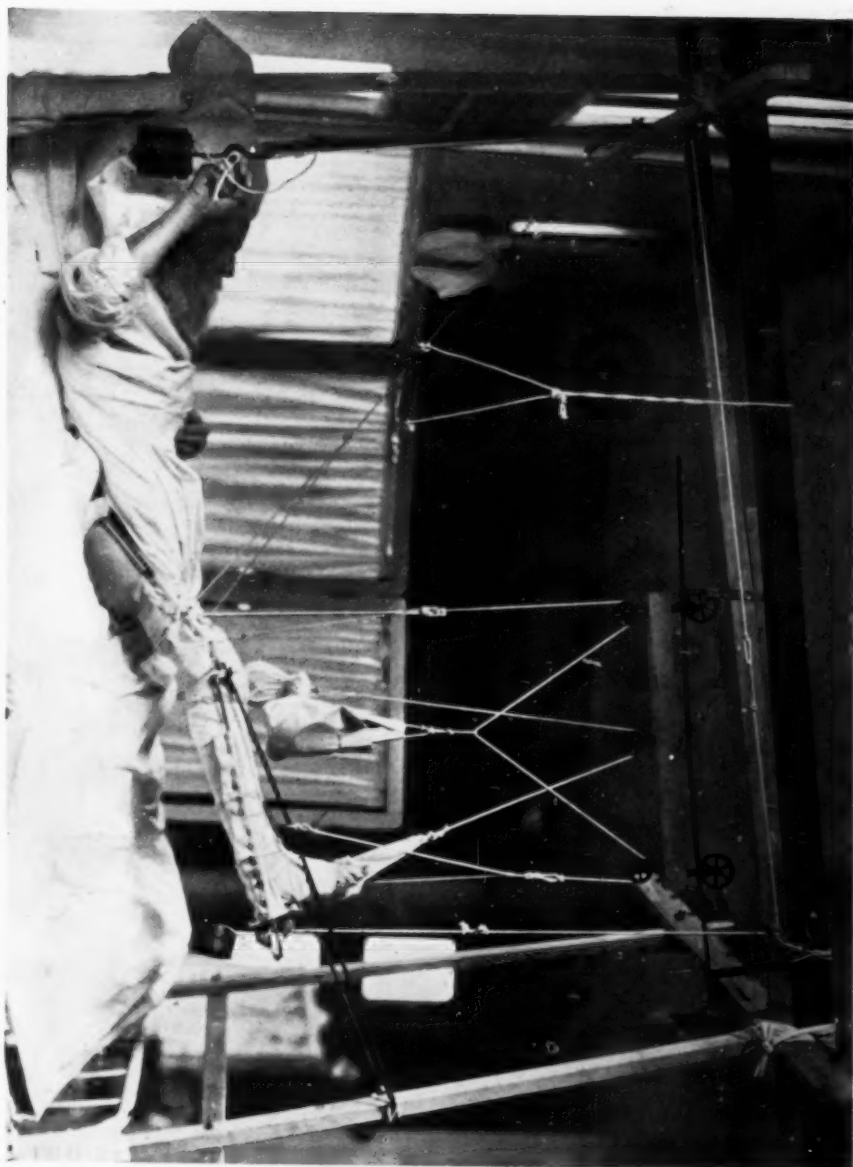


FIG. 7.—Same patient. Shows leg in mid-position.

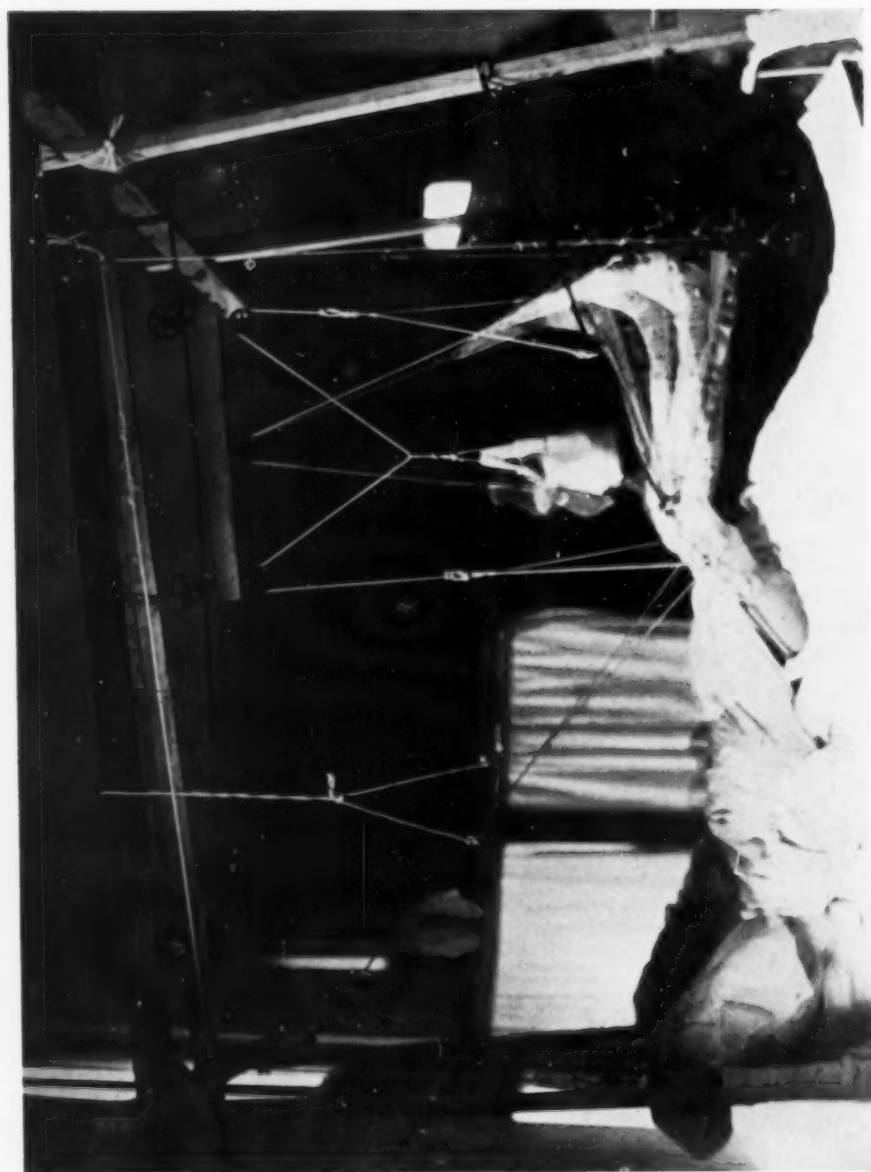


FIG. 8.—Same patient. Superimposed picture to show the range of movement.

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the bandaging to the legs of the beds could not be so firmly done, and the divergence of the uprights necessitated that the feet of the trestle be sawed level with the floor. This sometimes gave trouble on an uneven floor. However, the principal disadvantage was that instead of fastening the cross pieces with bolts and wing nuts, screws were used. Screws and screw-drivers had to be always on hand. In the original frame the screw nut was loosened, the frame collapsed, the two trestles and the overhead bar tied together with a bandage, and everything was ready for immediate use or transportation. When required, the bundle was brought



FIG. 9.—Patient walking with "caliper" splint. (See Figs. 6, 7, 8.)

to the bedside, the bandages untied, the trestles opened (Figs. 4 and 5), and the screw nuts tightened. The whole frame could be erected in two and one-half minutes. No hunting for screws, screw-drivers, etc., was necessary. In other words, the frame was a self-contained unit.

If the trolley is used, and it is necessary to elevate the foot of the bed, the wedge shown in Fig. 12 will be found a simple method of adjusting the level of the bar so that the trolley runs true.

In the early period of the war the dominant note in the treatment of fractures was immobilization. The majority of cases were encased in plaster, in which windows were cut, or metal arches made, to give access to the wounds. The immediate results were filth, infection, and gangrene; the late results, pressure sores, atrophied muscles, and ankylosed joints.



FIG. 10.—Intertrochanteric fracture of left femur. Patient, sixty-three years of age, treated by the balanced suspension and traction method. Splint (Thomas) with hinged auxiliary splint for exercising. Traction, direct skeletal, by Pearson's tongs applied to femur. Note patient holding traction cord in right hand. There is a paralysis of left side.



FIG. 11.—Leg in mid-position.



FIG. 12.—Superimposed picture to show the range of motion obtained in exercising. Note wedge inserted under iron strap so that the level of the trolley bar will be parallel with the ground when the foot of the bed is raised.



FIG. 13.—Showing balanced suspension and traction method of treating a fracture of neck of humerus.
Patient exercising the elbow-joint.

So much for the so-called orthopedic treatment of fractures. Blake states that in one of the best clinics where these methods were employed less than 2 per cent. of the wounded were returned to duty.

In France two schools developed: That represented by Delbet used limited fixation, and employed early functional use; this method resulted in shortening the time spent in bed, but not much in the time of healing. The second school disregarded immobilization by fixation, and strove for the preservation of function, which was obtained by applying the principles of balanced suspension and traction, with the limb in a position of physiological rest. One of the leaders of this school was our own Doctor Blake.

Conclusions.—It is a source of profound satisfaction that the frame played a part in simplifying the application of these cardinal principles; facilitated the application of the Carrel³ treatment; materially lightened the burden of the nursing problem; and that it was a decided factor in promoting the comfort and well-being of the Allied wounded. Its practical value is shown by its use throughout the French, Belgian, and American armies. It was also used by many British units.

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THE CHLORINE ANTISEPTICS *

By WALTER ESTELL LEE, M.D.
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THE use and abuse of many agents as antiseptics in the treatment of war wounds has been productive of an enormous literature. The pre-war methods of choice and use of antiseptics were entirely empirical, and when these same agents and methods were applied to the massive infections of gunshot wounds chaos resulted. It was not until the problem was approached in a scientific way by Wright, Dakin, Carrel and Dehelley, with adequate analysis of the chemical, physiological, biological and pathological factors involved, that any knowledge of the subject was obtained (Dakin and Dunham, "Handbook of Antiseptics," MacMillan and Co., New York).

That the human tissues have a very definite vital resistance to bacterial infection has been conclusively demonstrated in the recent surgery of gunshot wounds. The standard of surgical sterility established by Carrel as the result of his work with war wounds, one organism in three microscopic fields (1/12-inch oil immersion lens) represents from sixty to eighty organisms to one cubic millimetre of the exudate. A far cry from a condition of bacterial sterility. It is because of this vital resistance of the tissues that it has been possible to practice, in the war wounds, primary and delayed primary suture without the use of antiseptics. As a result of this experience surgeons in the future will have more faith in, and depend to a greater extent upon, the vital resistance of the patient's tissues than they have dared to do in the past.

This vital resistance of the tissues is, however, a variable quantity, being modified by constitutional disease, fatigue, shock, hemorrhage, starvation, and the necessary degree is not always obtainable. The elimination or adequate control of the factors of infection—the focus, the devitalized tissues, and the interval of time between the injury and the receipt of surgical treatment—is only possible in a certain proportion of cases. The mechanical closure of the wound and subsequent rest of the injured part cannot always be provided. For these reasons, at least, surgeons in the future will still require a certain amount of help from antiseptics in a definite proportion of infected traumatic wounds of civil life.

The new work upon antiseptics may be said to be based upon the following principles:

1. The laws governing chemical disinfection, which have been worked out by Chick (*Journal Hygiene*, p. 92, 1908–10, page 238, 1910), show that in all essential particulars the act of disinfection can be regarded as obeying the laws governing the simple chemical reaction, the disinfection

* Read before the Philadelphia Academy of Surgery, April 5, 1920.

tant representing one reagent and the bacteria the other. This conception is of the greatest importance, since the cardinal points of disinfection are thereby experimentally established, namely, *adequate active mass* or concentration of the antiseptic, the *necessary time* of action, and *perfect contact* between the reagents.

2. That the germicidal activity of all agents depends to an extraordinary degree upon the media in which they act, almost invariably showing the maximum in distilled water or salt solution. This was demonstrated very early by the workers at Compeigne who showed the fallacy of drawing conclusions from experiments and estimating the values of germicidal agents, unless the artificial medium employed was chemically similar to that of the human tissues.

The work of Dakin, Carrel and Dehelley with the chlorine group of antiseptics is now too well known to need but a reference, and has been fully confirmed experimentally and clinically by the military surgeons of the French, English, and American armies.

That chlorine could be presented to the human tissues without the destructive effect which has prohibited its use in the past, has been one of the surprising developments of the surgery of the war. The use of Dakin's dilute Labarraque's solution containing not more than 0.5 per cent. of hypochlorite was not followed by untoward effects in the infected war wounds as long as they contained devitalized tissue or profuse exudates, but it too frequently exhibited the inherent irritating effects of chlorine upon the skin surrounding these wounds. Recently Dunham ("Handbook of Antiseptics," MacMillan and Co., New York), experimenting with the web of a frog's foot, found that Dakin's solution of hypochlorite affected the tissues in an inverse proportion to their blood supply. Thus, when the solution was applied to the web, the superficial horny and relatively vascular layers were quickly destroyed, then more slowly the subcuticular tissue, but as the hypochlorite approached the blood-vessels its destructive action slackened and finally became arrested before the vessels were reached. There always remained a distinct unaffected zone about the blood-vessels. His explanation was that the protein of the blood plasma transuding through the vessel walls formed a chemical union with the active chlorine, and the resulting chloramine compounds acted as a neutralizing barrier to any destructive action of the hypochlorite solution upon the blood-vessels.

Hartwell and Butler made a clinical report of their work at Bellevue which not only corroborates this experimental work of Dunham, but exhibits a practical application. While no action of the hypochlorite solution was noticed upon living muscle tissue, with its rich blood supply, the relatively avascular tendon and cartilage were rapidly dissolved unless protected by active suppuration and exudation. In their work the use of the hypochlorite solutions was discontinued in these avascular tissues.

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The experiments of Gray (Johns Hopkins Hospital Bulletin, October, 1918) and the clinical class-room demonstrations during the war at the Rockefeller War Demonstration Hospital, showed the same phenomena in the tissues of the mesentery when Dakin's hypochlorite solution was injected into the normal peritoneal cavity of a cat. Our clinical experience during the last three years has been just as convincing that the hypochlorite solutions can be used with impunity in peritoneal cavities in which there are abnormal exudates, as in appendiceal and pelvic abscesses.

It is the presence in these peritoneal exudates of the necessary mass of chemical protein and its union with the active chlorine given off by the Dakin's solution that results in the formation of a chemical barrier which protects the normal peritoneal tissues from the destructive solvent action of the hypochlorite solutions. *Thus the danger to the human tissues from the use of Dakin's hypochlorite solution and all chlorine compounds depends upon the relative masses of active chlorine and on chemically available protein.*

Yet this peculiar solvent or proteolytic action of the hypochlorite solutions is now generally realized to have been its greatest asset in the treatment of war wounds. The small masses of devitalized tissue of the traumatic wounds of civil life can practically always be eliminated by the natural autolytic processes of the tissues and rarely is the *vital resistance* embarrassed, at least to such an extent as to endanger life as was the case with war wounds. The war wounds provided masses of dead tissue which were ideal culture material for rapid and virulent bacterial growth and the *vital resistance* was usually overwhelmed. The prompt and efficient removal of these dead tissues by the solvent action of the hypochlorite solutions, and in the latter years of the war by thorough mechanical excision, made the relative values of the mass of infection and the vital resistance of the tissues more like those of civil wounds.

The chemical reactions which occur when chlorine is presented to the tissues, as in the hypochlorite solutions, are almost infinite. However, Dakin and Dunham ("Handbook of Antiseptics," MacMillan and Co.) feel that the proteolytic action of these solutions is not due primarily to any action of the chlorine, but to the various salts which are secondarily formed. Thus, when NaOCl gives off its chlorine a hydrogen element unites with the NaO to form NaOH, sodium hydroxide. This hydroxide is one of the many inorganic salts formed, and it is this type of salts which act as the solvent agents and not chlorine.

The chlorine, as it splits off from the sodium compound, among numerous other reactions, unites with the protein to form amino-radical (NH_3) to form more stable compounds which are known as chloramines. As all bacteria are composed of protein, the chlorine reacting with bacterial protein exerts a *direct germicidal action*. These chloramines, though more stable than the hypochlorites, holding their chlorine while in the tissues from three to twenty-two hours instead of from seven to ten minutes as do the hypochlorites, also break down and liberate chlorine, and this

chlorine unites with other proteins. In just so far as the reaction of the chlorine be with bacterial proteins the chloramine exerts a *direct germicidal action* as did the original hypochlorite. This splitting off of the chlorine from the chloramines results each time in the formation of more and more stable chloramine compounds until a point is reached—after many hours—when the chlorine is so strongly bound to the amines that its germicidal possibilities cease. The practical bearing of all this upon the clinical use of the chlorine antiseptics, *sodium hypochlorite*, *chloramine-T*, and *di-chloramine-T* may be stated as follows:

1. The *direct germicidal effect* of all the chlorine antiseptics is dependent upon the liberation of their chlorine and the combination of this chlorine with bacterial protein.

2. The rapidity with which the *hypochlorite solutions* liberate their chlorine necessitates, in order to avoid the destruction of living tissues, the presence of large masses of available protein (devitalized tissues and profuse wound exudate) or the use of such dilute solutions that a safe margin in the relative masses of the active chlorine and available protein is insured. Thus the usable strengths of hypochlorite solutions, which should be less than 0.5 per cent., liberate such a small mass of chlorine that their *direct germicidal effect* is almost negligible. But, unlike the other chlorine antiseptics, they exert a very definite *indirect germicidal effect* by the formation of hydroxides which act as solvents of the culture material provided by devitalized tissues and wound exudate.

3. The *synthetic chloramines* are more stable compounds of chlorine than the hypochlorites and therefore can be used in greater concentrations or larger germicidal masses. They act practically as reservoirs from which chlorine is slowly and automatically given off as the tissues present the necessary reacting substances (bacterial or tissue protein). Dunham (*Surgery, Gynecology, and Obstetrics*, February, 1918, p. 152).

4. The *hypochlorite solutions* are indicated where there are large masses of dead and devitalized tissues or profuse tissue exudate which cannot be removed by mechanical means. They should not be used where such as are not present or applied to tissues poorly supplied with blood, tendons or cartilage.

5. The *chloramines* are indicated where there is but little, if any, dead tissue, and where the wound exudate is moderate in amount. Their only value is as a germicide. When in the human tissues, they slowly liberate their chlorine over a period of from three to twenty-four hours and in sufficient quantities to automatically unite with the bacterial and other proteins presented by the wounds.

TRANSACTIONS
OF THE
PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting held March 1, 1920

The President, DR. GEORGE ROSS, in the Chair

INTRA-ABDOMINAL HEMORRHAGE FROM RUPTURED CORPUS LUTEUM

DR. JOHN SPEESE reported the history of a woman, aged twenty years, who was admitted to the Presbyterian Hospital September 1, 1919, complaining of severe abdominal pain and vomiting. The attack began August 31, 1919, at 11 P.M., was sudden in its outset, the pain was localized to the right side in the beginning, but later extended over the entire abdomen, and at the time of admission was again localized in the right iliac fossa. Vomiting occurred after taking some medicine, bowels have been regular, no diarrhoea. Patient says she had a similar attack eighteen months ago.

Menstruation regular and normal, and the last period twenty-two days ago. Patient has been married for two years, has had no children and no miscarriages. Vaginal examination was negative. Leucocytic count 18,850. On opening the abdomen a large quantity of fresh blood was found free in the abdominal cavity, and large clots in the pelvis, the picture being that of a ruptured ectopic pregnancy. The right ovary was enlarged and on examination a point of rupture was noted, from the torn edge of which a constant but small stream of blood escaped, the hemorrhage evidently coming from a small vein. The tube appeared normal, as did the opposite tube and ovary. The ruptured ovary and the appendix, which was the seat of a chronic lesion, were removed.

The patient made an uninterrupted recovery, convalescence being delayed by the secondary anæmia (hæmoglobin, 40 per cent.; red blood count, 2,520,000), which responded rapidly to medical treatment.

Pathological Examination.—The ovary of normal size has on its superior surface an irregular ragged opening which measures 3 by 1.5 cm. The rupture involves almost the entire surface except 1 cm., where the ovarian tissue appears normal. Sections taken from the edges and base of the torn area reveal the usual picture of a corpus luteum and no evidence of the existence of pregnancy.

At the time of operation the condition was regarded as an ovarian pregnancy, but careful microscopic study of the specimen failed to show this condition. The case must, therefore, be classified as one of ovarian hemorrhage following rupture of a corpus luteum. Bovee (Gynecologi-

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cal Transactions, 1918, xliii, 76) has studied exhaustively the subject of tubal and ovarian hemorrhage, and states that hemorrhage from the ovary may be confined within the ovary, constituting one or more hæmatoma, or it may take place into the peritoneal cavity, producing, if abundant, a hæmatocele. In the former variety it may occur in the stroma, into new growths, or into follicles in any stage of development. If before or during follicular hemorrhage rupture of the follicle or of the wall about a stromal active hemorrhage occurs, the peritoneum may be deluged.

The majority of cases occur during or within a few days of the menstrual period, and the changes in the ovary at this time are in all probability the most important predisposing factors. While various varieties of hemorrhage may take place in the ovary, hemorrhage from the corpus luteum, with resulting intraperitoneal hæmatocele, seems so simple and easy that Bovee wonders that it is recognized so infrequently.

The case reported follows the usual history of these instances of ovarian hemorrhage due to rupture of a corpus luteum, the rupture occurring six days before the menstrual period, was not preceded by any trauma or strain. The symptoms were not characteristic, and resembled those of appendicitis. In view of a previous attack, the absence of shock and a negative menstrual history, this diagnosis was made and perhaps not enough attention directed to the slight degree of pallor present, and only a leucocytic count made before operation. The presence of hemorrhage was not discovered until operation, which fortunately was performed immediately after admission to the hospital.

FECAL FISTULÆ WITH MULTIPLE JOINT INFECTION

DR. ARTHUR E. BILLINGS reported the history of a boy, aged five years, who was referred by Doctor Niles, of Carbondale, Pa., July 19, 1919, to the service of Doctor Gibbon at the Jefferson Hospital.

His chief complaint was profusely discharging fecal fistulæ in the right lower abdominal quadrant. He had been operated upon three years before for an appendicial abscess, and a short time after this he was operated upon a second time for the closure of a fecal fistula which developed soon after the appendix operation. He was then seen by Doctor Niles who found multiple openings on examination, and tried to close the fistulæ by suture without resection, but the attempt was unsuccessful. The patient's mother stated that he had not had a normal bowel movement for nearly three years, all fecal discharge occurring through the fistulous openings in the abdominal wall.

Physical examination did not reveal anything abnormal except in the abdomen. He was a little small for his age, but was fairly well nourished. The abdomen was not distended or tender except in the region of the old scars and the four fistulous openings which occupied most of the right lower quadrant. The two smaller openings were external and the two

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larger ones were on the inner side of a rather long oblique incision which extended almost to the midline just above the pubis. There was marked eversion of mucous membrane about all the openings, particularly the larger two, either of which would admit one or two fingers.

Doctor Manges demonstrated by fluoroscopic and skiagraphic examination after barium meal, barium enemata and injection of barium through the fistulæ, that the two outer openings were in the cæcum and the two larger ones were in the descending colon or sigmoid; one filling the segment of colon above and the other the sigmoid and rectum.

The urine was negative on admission and subsequently, except for a trace of albumin and a few hyaline casts immediately after operation. There was no leucocytosis, and the temperature was practically normal (running up to 99.3 on two or three occasions) from the time of admission to operation August 4, 1919; during which time there had not been any discharge of fæces by rectum.

The patient was anæsthetized with chloride of ethyl and ether. The abdomen was cleaned with benzine and the fistulous openings were closed with continuous sutures to prevent leakage during operation. The field was again cleaned with benzine and then painted with tincture of iodine. An oblique elliptical excision of the fistulous openings was then made in line with the old scar. As the abdomen was opened and the adherent intestines separated the peritoneal cavity was protected with gauze packs. The cæcum was separated from the mass and the two openings which were on the anterior and inner surfaces were closed with a series of inverting chromic catgut sutures. The other two openings, which were found to be due to a complete division of the sigmoid down to its mesentery, were closed, after separating and freshening its ends, by doing an end-to-end anastomosis with a double suture line of chromic catgut. The abdomen was closed with considerable difficulty (because of loss of tissue and scar formation) around two rubber-covered gauze drains. The patient was in fairly good condition at the end of the operation. On the second day after operation his temperature went to 102° and his pulse to 170 with evidence of a good deal of infection in and about the wound, without vomiting or much distention. His pulse-rate by the third day had dropped to between 100 and 120 with a temperature a little above 100°. By this time there was considerable purulent discharge from the wound which was characteristic of a colon bacillus infection. His temperature was not quite normal until seventeen days after operation. The wound was discharging pus freely, but had discharged very little, if any, fecal matter. On September 25th his temperature rose to 102° with pain about the right knee-joint; and in forty-eight hours both knees were swollen and distended with fluid, but not very tender. Leucocytes, 7200. There was no redness or heat about either joint. Temperature on October 1st, six days after onset of pain, was normal. A few days later the left and right ankles were successively involved with less acute signs than were mani-

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fested in the knee-joints. The temperature continued irregularly then for the next two months between normal and 100°.

With considerable periarticular thickening about all of the joints involved, X-ray showed cloudy distention of both knee-joints without evidence of bone involvement. Otherwise all were negative. All of the involved joints were fixed with splints and saturated solution magnesium sulphate dressings with ice-bags were applied until all acute symptoms had subsided. The abdominal wound had healed except superficially where there had been considerable skin separation. Blood culture was negative on September 30th, and the leucocyte count was not recorded above 9500.

The patient was discharged with good joint function, but with definite thickening about all of the involved joints, more particularly in the knees. None of the joints were aspirated and there is no positive evidence that there was a direct connection between the abdominal and joint infections, although this probably was the case.

DR. A. BRUCE GILL thought it very possible that there was a connection between the abdominal infection and the infection of the joints. He thought colon infection of joints to be rather common. He recalled the case of a boy who came up from North Carolina to the Presbyterian Hospital whom he saw in consultation with Doctor Wharton. The boy gave a history that about a week previous to an acute onset of arthritis of the knees he had a severe intestinal disturbance, which began with a sudden fainting attack and continued with fairly high fever. After the onset of the arthritis he was treated at home for a while for rheumatism, and was then brought to Philadelphia as he was showing no improvement. A culture of a sterile catheterized specimen of urine was made and it was found to contain a colon bacillus in pure culture. An autogenous vaccine was administered, and the patient showed rather rapid recovery. He left the hospital a few weeks later almost completely cured.

On several other occasions in cases of chronic arthritis he had found a pure colon infection of the urine. One writer, whose name he did not recall, believes that in cases of focal infection anywhere in the body the microorganism which causes the infection can usually be recovered in the urine. While this does not prove that the arthritis is due to the colon infection, it is at least suggestive. Arthritis which is due to colon bacillus infection frequently runs a rather mild course and recovers without any sequelæ. He thought it likely that many cases of chronic hypertrophic arthritis are due to colon bacillus infection.

THE RELATIVE VALUES OF RADIUM AND SURGERY IN THE TREATMENT OF TUMORS OF THE PELVIC ORGANS

DR. JOHN G. CLARK then pronounced the annual oration before the Academy, for which see page 683.

JOHN H. GIBBON said that it was an inspiration to observe the work

RADIUM IN PELVIC TUMORS

which has been done in the Memorial Hospital in New York, for instance, by the coördinated work of surgeon, röntgenologist, and pathologist. He was persuaded that the time is coming when surgeons will probably not operate in cases of cancer of the cervix, in certain cancers of the mucous membrane, and cancer of the tongue. Cancer of the tongue is extremely difficult to cure by operation alone, and he believed that it will soon be shown that better results are obtainable by the use of radium.

He protested against operation in far advanced and in inoperable cancer, and also in those cases where metastasis had already occurred. Operation in these cases is a sad commentary on surgical judgment. Such operations only confirm in the minds of the laity an idea that is already prevalent, that surgery is of no avail in cancer. Every such patient operated upon is educating the public in the wrong way. It is far better to decline to operate, allowing it to be understood that relief through surgery was sought too late.

DR. E. E. MONTGOMERY approved the stand taken by Doctor Clark. The radium is not to be applied in the larger growths and particularly in those where there are complications. It occurs not unfrequently in fibroid tumors that the growths in order to adapt themselves to the configuration of the pelvis cause more or less twisting of the organ, which torsion affects first the venous circulation, because of the less resistance of the veins. The firmer arteries permit blood to be pumped in and the growth rapidly enlarges, vessels rupture and fill with blood, or it escapes into the abdominal cavity. A hæmatoma may thus be formed in both ovaries. The employment of radium in such cases would seem provocative of trouble rather than affording relief. He operated yesterday upon a woman who had a number of fibroids in her uterus. When the abdomen was opened evidences of free blood almost equal to those seen in ruptured ectopic gestation were seen. The situation of the tumors had led to torsion and rupture of the vessels in the ovaries and the presence of the hæmatoma.

In regard to carcinoma he had seen some remarkable results from radium in recurrences following operative procedures. The disease would clear up and for two or three years there would be entire freedom of any sign of the disorder. When it did recur it would be in deeper structures and free from the annoyance of the superficial disease. The cessation for a time was a demonstration of the great value of this agent. In some cases apparently non-operable, the action of radium seemingly brings about such change as to permit subsequent operation with apparently good results. Where, however, the limitations of the disease permit of operation in healthy tissue and the possibility of entire removal of affected tissue, the knife should be the method employed for its eradication.

In regard to apparently non-operative cases, he remembered a number where the cervix was so completely destroyed as to make it questionable to his mind whether operation should be resorted to, that have

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lived fifteen, twenty, and twenty-five years following the removal of the uterus.

He had seen other cases, in which the disease was circumscribed and he felt that no hesitancy existed in promising a favorable result where operation was followed in a few months by recurrence in a virulent form rapidly ending fatally. Much is still to be learned of the character of cancer, the resistance of the patient, and the probabilities of its extension and recurrence. All know that when the disease occurs early in life, prior to the fortieth year, it is almost certain to recur even though the case undergoes early operation.

DR. HENRY K. PANCOAST said that the results that Doctor Clark has gotten he did not think could be duplicated by every one. In the use of radium one has to command, first, common sense; secondly, a knowledge of physics; thirdly, a knowledge of gynecology. All of these are absolutely essential. A great many men have been using radium in the treatment of gynecological conditions and consider little beyond the gynecological aspect of the cases, and their results will not be routinely promising as are to be expected in the judicious use of the radium. In the early days of radium therapy it was usually in the hands of röntgenologists. The use of radium belongs really to the gynecologist and not to the röntgenologist, unless he is doing that work as a special line along with his röntgenology. Doctor Clark's results have been obtained after the most careful work and the most judicious use of the therapeutic agent he has employed.

THE CHLORINE ANTISEPTICS

DR. W. ESTELL LEE read a paper with this title, for which see page 772.

DR. JOHN H. GIBBON emphasized the fact that this subject is just as important now as it was before the war was over, because as far as surgery goes it has been the greatest product of the war. He thought there could be no doubt that the treatment of infected wounds had been revolutionized by the war. He thought Doctor Lee's summary, for one who has been so enthusiastic about one of these preparations, to be a very just summary. He would question the destructive quality ascribed to the hypochlorite solution in fairly clean wounds, for the reason that he had seen it used so extensively in clean wounds without any clinical evidence, at least, of sloughing. The British injected "eusal" into joints and there was very little difference between what took place in those joints and what took place in joints where they used ether or salt solution. One of the most important things that Dakin did was to show that the majority of antiseptics that surgeons had been using for years were valueless because of the way they had been used. This is due to the loss of their germicidal qualities in a short time, due to contact with organisms and wound secretions. To pack a wound with gauze saturated with an antiseptic solution once a day is perfectly useless. In order to obtain

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any benefit the antiseptic must be constantly applied. Carrel says: "If it be supposed that each microbe divides every half hour it will give birth in twelve hours to more than fifteen million other microbes." This idea of keeping up the bacteriocidal action of agents is one of the greatest things that has come out of the war. Another great advance is the mechanical sterilization of the wound. He was convinced that the conflicting reports about the various antiseptic agents that have been used—that is, one man claiming that Bipp, another that flavine, another that salt solution, another that hypochlorite is the only thing to use—is due to the fact that in the later months of the war the wounds did well because they were properly débrided, that they had undergone a proper mechanical sterilization, and not because of the employment of any agent. Therefore, it comes down to the question as to what can be done in the infected wounds, and here there has not been any antiseptic that is comparable to the chlorine group.

DR. JOHN H. JOPSON making a comparison between the results obtained by the antiseptic treatment of infected wounds, and closure of the same after reduction of the bacterial content to a certain point, with fresh wounds containing a similar number of bacteria per field, said that one must bear in mind that there are certain factors to consider besides the count. It might be perfectly safe to close the first with a count of one in three fields, and not the second. There is no doubt that the virulence of a particular strain is often reduced by prolonged antiseptic treatment, at least in the same individual. Again, it is never safe to depend on count alone, as a differentiation of the infecting organisms is always necessary to exclude the futile and dangerous attempt to close over a streptococcus, however few in numbers it may be. Wherever a streptococcus has been found at any time, at least two cultures negative for that organism must be obtained at successive times before delayed primary or secondary suture is made.

A certain organism may acquire an immunity to one antiseptic after prolonged treatment, and succumb quickly to another. We have seen this exemplified in a stump in which prolonged Carreling had failed to eradicate a streptococcus, although the count was low, and the stump looked healthy. A very few applications of dichloramine-T sufficed to eliminate the streptococcus, and a successful secondary suture was done. If we agree with Carrel that the only external agents which can influence the time of healing are those making for sterility of the wound, it is evident that this acquired immunity is the explanation of the well-known clinical fact that occasional change in the manner of dressing granulating wounds is often of decided benefit.

DR. F. O. ALLEN said that he did not think surgeons appreciated the value of dichloramine-T in the treatment of infections, such as boils, abscesses, broken-down glands, and so forth. He had followed Doctor Lee's work since he first began it and had become very much impressed

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with the value of dichloramine-T in local infections, what might be called superficial infections. In any situation where there is a cavity filled with pus that can be thoroughly drained, even in large breast abscesses, packing with gauze saturated with dichloramine-T solution gives results far better than any other treatment he had ever seen. In almost all such instances the abscess cavity can be pretty thoroughly sterilized in one or two days, and after that it closes rapidly.

TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY

*Regular Meeting, Held at the New York Academy of Medicine,
February 11, 1920*

The President, DR. WILLIAM A. DOWNES, in the Chair

LOBECTOMY FOR BRONCHIECTASIS

DR. JAMES M. HITZROT presented this case of lobectomy for bronchiectasis and multiple abscesses of the lung in a girl aged seventeen years, admitted to the Medical (Cornell) Division of the New York Hospital on November 29, 1915, with a history of pain in the right chest of five days' duration. The family and past history were negative. The physical signs on admission were those of a pleurisy without effusion. The temperature ranged from 101°-104.4° F.; white blood count, 29,000; polymorphonuclears, 86 per cent.

Six days after admission (eleven days after the onset) there were signs of fluid in the right chest. These signs increased, and on the fifteenth day after the onset the chest was aspirated, and a grayish-green pus of foul odor which gave a culture of *Streptococcus viridans* and of *Staphylococcus albus* was obtained. The patient was transferred to the first surgical division and on the sixteenth day after the onset thoracotomy with resection of the seventh rib in the post-axillary line was done, and a large amount of very foul-smelling, thin, greenish pus evacuated. She drained profusely and was finally discharged January 24, 1916, five weeks after operation, and sent to the country, where she remained well for three weeks. She then had fever and chills, and the old wound was reopened at the White Plains Hospital and considerable pus evacuated. She was readmitted to the New York Hospital on March 7, 1916, with a discharging wound. After removing the drainage tube and irrigating the chest cavity with Dakin's solution the temperature fell and the wound closed in ten days. The patient had gained in weight since her first admission, and was again sent to the country on March 19, 1916. She was readmitted May 28, 1916, with a history of malaise and fever. An X-ray showed fluid in the right chest. The wound was reopened and discharged for two weeks, after which it again closed and the patient was sent to her home. She was readmitted on October 12, 1916, with a history of having been fairly well during the summer, except for troublesome cough, which was worse at night and in the morning, but with little sputum. Two days before her last admission she caught cold and

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since then had had fever, pain in the right chest, and increasing cough and expectoration. On October 14, the X-ray showed a localized collection of pus in the region of the old scar. The wound was reopened, a large portion of the seventh rib resected, and the cavity irrigated with Dakin's solution, through two Carrel tubes. She was discharged on November 14, with a practically sterile wound which involved only the chest wall.

The wound gradually closed, but in January, 1917, reopened and discharged pus freely. She was readmitted on February 6, 1917, when three ribs were resected in the region of the old scar and two abscess cavities drained. She remained in the hospital a month and was then discharged with a granulating area in the drainage area.

From March, 1917, to January 19, 1918, the patient remained fairly well, except for an occasional discharge from one of the drainage sinuses. The cough which had come at irregular intervals previous to the last operation disappeared for a short time, but was now more persistent, and she brought up an increasing amount of sputum.

Up to this last admission the above record was from that at the hospital and Doctor Hitzrot said he was indebted to his confrères on the staff for permission to use this history.

Examination of her right chest on January 19, 1918, gave the physical signs of thickened pleura, fluid in the chest, and a slightly amphoric quality to her breathing was noted at the angle of the scapula. The sputum was large in amount, of a faintly sweetish, sickening odor, and was coughed up in paroxysms. It was negative for tubercle bacilli and elastic tissue. The X-ray examination showed fluid, a small cavity in the lung about the level of the angle of the scapula, and areas in the lung suggestive of some type of infiltration. "Doctor Busby."

The rational diagnosis seemed a bronchiectatic cavity or cavities in the lower right lobe of the lung communicating with the pleura. On January 30, 1918, she was operated upon by a long incision through the seventh interspace, and the ribs spread by a rib retractor; the lung was densely adherent everywhere. In the region of the old scar there was a group of sacculated cavities in the pleura, which communicated with an infiltrated area in the upper portion of the lower lobe. The lobe was dissected free with considerable difficulty, the root of the lung ligated, the bronchus crushed and ligated with heavy chromic ligatures, and the lobe removed. The remainder of the lung was then mobilized. A counter-opening was then made between the ribs in the most dependent portion of the chest cavity and drainage by the Kenyon method instituted. The intercostal wound was completely closed.

The discharge, which at first was serous, later became thin, greenish, and foul-smelling, and the wound broke down in the region of the old scars and became gangrenous. The discharge continued for eleven days; then the wound gradually became clean and the patient was discharged eleven weeks

MYXOCHONDROSARCOMA OF THE HUMERUS

after operation, with a small granulating area about a small sinus which at that time could not be proven to communicate with a bronchus.

Two months later the patient returned with a distinct whistle in the sinus upon coughing (bronchial fistula). The fistula opened and closed from time to time up to January, 1919, when it finally closed and has remained closed up to the present. The cough has disappeared, the patient no longer has pain in the chest or fever, and since January, 1919, has remained entirely well.

The specimen removed could not be found by the pathologist, or Doctor Hitzrot would have shown it. The report of the pathologist stated that the lung was the seat of a bronchiectatic cavity about half-way between the periphery of the lung and a large bronchus, and communicated with the bronchus and the pleura. The bronchioles throughout the lobe were surrounded by small miliary abscesses. These miliary abscesses contained a streptococcus, but the type was not mentioned.

Doctor Hitzrot showed an X-ray plate, taken October 10, 1919, showing the chest cavity after complete healing. The lung had expanded and there was nothing abnormal except the thickened pleura at the base of the pleural cavity.

DR. HOWARD LILIENTHAL said that he had found that a lobectomy in a person in whom operation had been done previously for drainage to be most difficult. It was much easier to take out a lobe primarily than after it had become adherent to the chest walls. It was interesting to see that Doctor Hitzrot had gone through the refinement of isolating the bronchus in the hope of avoiding a bronchial fistula, but this was not necessary, as a bronchial fistula far from the chest wall always closed anyway; he had never had one that did not close. The case was also interesting because empyema complicated the other condition; that is, the empyema was secondary to the lung abscess. He had always been a little afraid of operating in those cases because of difficulties with adhesions. The case was also notable on account of the absence of any foreign body and yet it was bronchiectatic in nature. He believed that most chronic lung abscesses had an element of bronchiectasis because of the long-continued compression of portions of the bronchial tube caused by the exudate.

MYXOCHONDROSARCOMA OF THE HUMERUS

(Five years after operation)

DR. JAMES M. HITZROT presented a man shown before the Surgical Society, February 10, 1915 (reported in the *ANNALS OF SURGERY*, June, 1915), as a myxochondrosarcoma of the humerus.

On his admission to the New York Hospital, in May, 1914, the man had a pathological fracture through a cyst in the middle portion of the humerus. At the operation, eight days after the injury, the cavity in the humerus through which the fracture occurred contained tissue which resem-

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bled cartilage and infiltrated or cedematous connective tissue. The surrounding tissues and the muscle planes were densely infiltrated by tissue of similar appearance. A frozen section made from the tissue was reported as a myxochondrosarcoma.

As permission to amputate the arm had not been obtained, and as the evidence for that procedure was not sufficiently convincing, the diseased bone was completely excised, together with sufficient of the involved surrounding tissue to reach less infiltrated tissue. An eight-inch bone graft was then placed across the gap and the wound closed.

X-ray plates were made at frequent intervals and showed the bone-graft gradually becoming healed and new bone forming about it. The picture, seven months after operation, showed a curious vacuolated appearance of the bone in the region of the graft, which was regarded as suspicious. This, however, did not change particularly in the succeeding months, but at the one-year interval began to show signs of condensation and solidification. Pictures taken during the five years which have elapsed since the operation had shown a gradual thickening of the bone with the formation of a new medullary canal and no evidence of a recurrence.

Doctor Hitzrot said he believed that the original tumor was probably a central chondroma or myxochondroma of the type described by Virchow, and that the tumor was essentially a benign one. The infiltrated tissue existed in the face of the time elapsed, and the subsequent course of process might be considered as excessive callus formation.

The tissue removed was still a question of dispute from the histological standpoint, but the long interval which has elapsed, in Doctor Hitzrot's opinion, was sufficient to make him believe that the condition was not a sarcoma.

The condition further demonstrated the difficulty encountered in the diagnosis of bone tumors, especially such as had undergone pathological fracture, and, despite Doctor Bloodgood's criticism, Doctor Hitzrot believed the procedure used for this case met the condition at operation better than the simple curetting which Doctor Bloodgood believed would have been sufficient.

There was now no indication of any bone growth which could be considered abnormal.

DR. HOWARD LILIENTHAL referred to a case in the service of Doctor Neuhof at Mt. Sinai Hospital in which there was a tumor of the femur but no fracture. On opening the bone it was found to contain a peculiar yellowish material in what was at first thought to be a bone cyst. It was curetted out down into healthy marrow, and when this was completed only the shell of the femur was left. The pathologists spent a long time making up their minds what the condition was, but concluded that it was an osteochondroma and did not make a diagnosis of sarcoma; hence the prognosis given the

PLASTIC OPERATION ON SCALP

patient was good. Doctor Lilienthal said he wondered if this could be a case of the same kind as had been presented this evening; the sections looked very much like it.

PLASTIC OPERATION ON SCALP

DOCTOR HITZROT presented a man, fifty-three years of age, who was admitted to the First Surgical Division (Cornell Division) of the New York Hospital, October 9, 1919, referred by Doctor Oliver, with a history of having been burned on the face, scalp, and both hands by an explosion of cocoa dust April 25, 1918. He was treated in Burlington, Vermont, for second degree burns. The face and hands healed but ulcers had persisted upon the dome of the scalp, reforming from time to time since the injury, and never completely closing.

On admission, there were seven ulcers over the dome of the skull. After cleaning up the scalp the ulcers were grafted with Thiersch grafts. The grafted areas healed but, as the patient had stated on his admission, when one set healed a new lot of ulcers broke out. This occurred while he was under observation, and it seemed that the cause of this ulceration existed in the contraction of the burned area of the scalp over the rigid dome of the skull. While the skin was slightly movable it was very tightly stretched across the skull.

Acting on this premise, on December 9th, a pedunculated flap was made on the anterior surface of the left forearm with the pedicle toward the wrist. The ulcerated area of the scalp was then excised, dividing the occipitofrontalis fascia with the skin, the flap sutured into the gap this made, and the arm supported by a plaster splint previously prepared and worn by the patient for several days before the operation.

The first dressing was made seven days after the operation and the flap was viable except for a small area near its right posterior extremity, where it looked a little blue and somewhat dubious.

On the ninth day after operation the position had become so uncomfortable and the discharge at the base of the pedicle was causing so much irritation that the base of the flap was divided. The flap healed without subsequent change. The dubious area apparently only involved the skin, and after the epidermis had died and was removed, it rapidly healed. The anterior edge of the flap was pressed down by adhesive plaster on the twelfth day after operation.

At the operation Thiersch grafts were placed over the raw surface left on the arm and strapped into place by adhesive plaster. These all took and the arm was practically healed at the end of two weeks.

The features of interest in this case were: First, the ulcerations due to contraction of the scalp and the consequent disturbance in the nutrition of the skin; second, the rapidity with which the flap became vascularized, and, third, the endurance of the patient of a very uncomfortable position for nine full days.

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LIGATION OF COMMON CAROTID WITH STRIP OF FASCIA FOR ANEURISM

DR. JOHN DOUGLAS presented a colored man, aged sixty-three years, who gave a history of syphilis twenty-three years previous to his admission to Bellevue Hospital on June 12, 1919. A pulsating swelling had been present in the right side of his neck for five months. He had been hoarse for three weeks and suffered from severe headache for two weeks. His Wassermann was negative. Examination showed an aneurism about 3 x 5 centimetres in diameter just above the clavicle on the right side. After a preliminary course of treatment with salvarsan, mercury and iodide, which did not modify his objective or subjective symptoms, he was operated on.

An incision just above the clavicle exposed an apparently normal, undilated portion of the common carotid below the aneurism. A strip of fascia 5 cm. long and 1.5 cm. wide was removed from the fascia lata and wound tightly twice around the vessel, sutured, and then wound a third time and again sutured, stopping all pulsation above the ligature.

This method of ligature with a fascial strip, which Doctor Douglas had previously employed in a similar case five years ago, was used, as the fascia seemed to him superior to any of the usual ligature materials for three reasons: If properly applied it could not slip, would not be absorbed, and allowed a return of the circulation later, and even if the wall of the vessel were diseased it would not cut through, but would strengthen rather than weaken the area.

After operation, there was a disappearance of the headache and hoarseness, and the mass in the neck gradually diminished in size. There has been no return of the pulsation up to the present time, eight months later, and he had returned to his occupation as a laborer. The tumor was greatly reduced in size, being now no more than one centimetre in diameter.

DR. ELLSWORTH ELIOT, JR., said that while the use of a piece of fascia in ligating an aneurism was a desirable thing, he thought the use of an ordinary ligature applied with aseptic precautions accomplished the same result. For this purpose he had used chromic gut with a double ligature with satisfactory results. In illustration he mentioned the result in a case of ligation of the first part of the right subclavian artery, originally reported in this society for an aneurism of the third part. A ligature applied in this way was supplemented by separate ligation of all the branches except the vertebral and those of the thyroid axis with a very satisfactory result.

The patient now, nine years after the operation, was able to do the work of a plumber, and although this occupation required considerable abduction of the arm, no recurrence had ever developed. In persons with a specific history such a recurrence of the aneurism in the same or a nearby artery was not uncommon, and from the danger of this recurrence the patient was not entirely free for a number of years.

HYPERPLASTIC TUBERCULOSIS OF COLON

FAT TRANSPLANT FOR ADHESIONS AFTER TENORRHAPHY

DR. JOHN DOUGLAS presented a woman who had cut her thumb in September, 1919, on a broken preserve jar, severing both the flexor longus and brevis pollicis, just distal to the metacarpophalangeal articulation. They were sutured with 00 chromic catgut a few hours later. The wound healed by primary union and the thumb was kept in a position of flexion for three weeks, when motion was gradually resumed. Six weeks after operation it was found that there was no flexion of the terminal phalanx, all motion being at the metacarpophalangeal joint. It could not be determined whether this was caused by a separation, due to the use of chromic gut, of the long tendon or was caused by its adhesion to the palmar surface of the first phalanx.

The patient was again operated on nine weeks after her accident. The tendon was firmly united, but was also very adherent to the phalanx. As it was believed that these adhesions would reform if only freed, a thin strip of fat was removed from the thigh and wound around the tendon between it and the bone. There has been no reforming of the adhesions and function is now almost perfect.

DR. JOSEPH WIENER mentioned that in this case the finger had been immobilized three weeks following the operation. He formerly immobilized the finger following tenorrhaphy, but six or seven years ago began immobilizing the finger for a week only and then beginning passive motion, and in no instance did he get a non-union. It was advisable, in his opinion, to start early passive motion after every tenorrhaphy.

HYPERPLASTIC TUBERCULOSIS OF COLON

DR. EUGENE H. POOL stated that his only object in presenting this case was because it served to illustrate several points in connection with the paper of the evening. First, the difficulty of diagnosis between hyperplastic tuberculosis and malignant growth of the cæcum, and, second, the peculiarities of this type of tuberculous lesion. The diagnosis, he said, was often exceedingly difficult clinically, and even after the abdomen was opened differentiation between these two conditions might be impossible. Further, even microscopic examination did not always clear up the uncertainty at once. In this case three frozen sections were examined before the diagnosis could be made. This was because there was chiefly hyperplasia of the connective tissues with few tubercles and little or no caseation. The lesion, therefore, differed from that presented in tuberculosis elsewhere in that destruction of tissue was relatively slight and cell proliferation is excessive. The wall is greatly thickened, causing a tumor-like mass. The lumen of bowel was narrowed and there was little ulceration of the mucous membrane.

The patient was a woman, forty-two years of age, an Italian, who came under observation November 20, 1919, giving the history that for three months prior to admission to the hospital she had suffered from epigastric distress, and one month before admission she had begun to suffer severe

pain in the right iliac region. She had been treated for acute appendicitis outside the hospital. Three days before admission pain became very severe in the right iliac fossa, and was accompanied by vomiting. There was also an increasing constipation. The previous history was negative as regarded any symptoms suggestive of pulmonary tuberculosis, the patient having never suffered from colds or cough.

Physical examination showed nothing abnormal except the abdominal condition. Examination of the abdomen revealed a mass between the umbilicus and the spine of the ilium, hard, nodular, $2\frac{1}{2}$ inches in diameter, and fixed to the deep structures. Nothing else of significance was found. The temperature and pulse were about normal. The Wassermann was negative. X-ray examination of the chest showed a suspicion of tuberculosis. The leucocyte count was 10,000 with 72 per cent. polymorphonuclears. A bismuth enema passed only to the hepatic flexure and the cæcum seemed to be distended with gas. There was no macroscopic blood in the stools but the guaiac test was positive. The diagnosis was narrowed down to hyperplastic tuberculosis or malignant growth.

Operation.—An incision was made along outer border of right rectus muscle. On opening the abdominal cavity a rounded, firm, nodular mass was seen and felt involving cæcum. The mass at lower part measured about 8 cm. in diameter, and was bound down firmly to surrounding structures. The cæcum was dissected free and excised with several inches of ileum and the ascending colon, using the cautery, and preventing contamination by intestinal clamps across each segment. The end of the colon was inverted and closed. End-to-side anastomosis was then made between the ileum and transverse colon. Upon inspection no evidence of tuberculous involvement of any other part of intestine or abdominal viscera was seen. The wound was closed with two cigarette drains.

There was considerable exudate and some infection of the wound, otherwise the convalescence was satisfactory and the patient left hospital in good condition four weeks after the operation.

Pathological Report (by Doctor Elser).—Specimen consists of the cæcum, part of the ascending colon, and a part of the ileum. The cæcum and colon together are 20 cm. in length. About 10 cm. of this, including the cæcum, have greatly thickened walls, measuring 2 cm. in thickness at its greatest increase. The lumen of this portion is very narrow and almost completely occluded in places. This constriction is due to the greatly thickened, firm wall. The wall is tough and fibrous, showing a few small irregular yellow areas on cut surface, each 2 or 3 mm. in diameter. The mucosa of this part is rough and ulcerated. The ileum is about 6 cm. long and is adherent to the wall of the cæcum in part. The ileocæcal valve as such cannot be distinguished, but a probe can be passed from ileum into cæcum through a narrow opening. The mucosa of the upper 10 cm. of the colon of the specimen and the mucosa of the ileum appear normal, and the wall appears to be uninvolved. There is a large amount of fat around the cæcum and the ileocæcal valve. Lymph nodes, up to 1 or $1\frac{1}{2}$ cm. in diameter, are found in this fat and pericæcal tissue.

Microscopic Examination.—Frozen sections showed the lesions of a chronic pro-

HYPERPLASTIC TUBERCULOSIS OF COLON

ductive inflammation. The first two sections, made from different portions of the growth, showed no fully developed specific lesions which would warrant a positive diagnosis as to the nature of the process. It was not until a third section was made that definite lesions of tuberculosis were found.

Paraffin Sections.—Definitely tuberculous lesions are more numerous in these sections, but fairly large areas showing no specific lesions of tuberculosis are also encountered. Sections of the mucosa show extensive ulceration, with the presence of tubercles and miliary abscesses in the chronically inflamed submucosa. Sections of the regional lymph nodes show miliary tubercles and the lesions of a chronic inflammation.

DOCTOR POOL said that there was another type of chronic productive inflammation of the cæcum, namely, that due to actinomycosis. This possibility should be always borne in mind.

In general, however, when the wall of the cæcum was extensively involved by a chronic connective tissue hyperplasia a microscopic examination of various parts of the wall would usually show the cause to be tuberculosis.

DR. SEWARD ERDMAN presented two cases in which resection had been done for hyperplastic tuberculosis. The reports of both of these cases are included in his paper (see page 637).

DR. WILLIAM A. DOWNES presented a specimen and several lantern slides of a case of hyperplastic tuberculosis similar to the cases just presented.

This patient, Doctor Downes stated, was admitted to St. Luke's Hospital, January 29, 1918, supposed to be suffering from acute appendicular abscess, and was operated upon for suppurative appendicitis. An abscess was found at the base of the appendix, which was opened and drained with rubber dam drainage. There was considerable thickening and hardening about the site of the abscess, but not very thorough examination of the intestines was made. After about a month the patient returned with a small sinus, which opened and closed from time to time. The pathologist reported that the examination of appendix showed tuberculosis.

In December, 1919, the patient returned and the X-ray plates shown were taken. A resection of the ileum was done with a lateral anastomosis between the ileum and the transverse colon.

DR. L. T. LEWALD presented a series of lantern slides which showed the X-ray findings in Doctor Downes' case of tuberculosis of the cæcum. He stated that the slides brought out the point made by Doctor Brown and also observed in a series of cases operated on by Archibald and Pirie. Pirie, of Montreal, said that he did not at first diagnose tuberculosis because the colon would not fill and this fact was borne out in the study of a series of cases. Later, Pirie stated that this was the diagnostic sign of importance in differentiating tuberculosis of the cæcum. The bismuth passed through and did not fill the affected area because the cæcum was irritable. In tuberculosis the extent of the filling defect was usually much greater than in the presence of a new growth and this might be true of other conditions, as, for instance, amœbic dysentery. Hence, this point, Doctor LeWald said, was diagnostic of tuberculosis. Doctor Brown brought out the point that if one studied

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these cases between the fourth and seventh hours after the ingestion of the bismuth meal, at no time would the cæcum be filled. This was true even in fairly early cases without a large amount of hyperplastic tissue. The bowel passed the contents on and did not allow the diseased portion to fill. Plates made at the end of twenty-four hours showed that the opaque meal had passed to the descending colon or had been eliminated, but failed to fill the cæcum. Now, if the bowel were cleared out by any means and then an injection opaque to the X-ray given, the injection would flow as far as the diseased region, usually to the right side of the colon, and then, instead of, as in a normal case, continuing on and filling the cæcum, and even in some cases going through the ileocæcal valve, it would in these cases of tuberculosis stop at the involved region.

Another plate showed the result of the chest examination in Doctor Downes' case, which was absolutely negative. The case was interesting on that account, because tuberculosis might be either primary in the bowel or there might be a focus in the chest from which it originated. The specimen after removal showed the identical thickening of the wall and narrowing of the lumen of the cæcum as shown by the X-ray. The form of tuberculous hyperplasia shown in this case was the most common type.

HYPERPLASTIC TUBERCULOSIS OF THE INTESTINES

DR. SEWARD ERDMAN read a paper with the above title for which see page 637.

DR. GEORGE WOOLSEY said that he had had several cases of this class at rather long intervals, and thought the diagnosis to be often rather uncertain even after one had opened the abdomen. In his experience he had seen rather little carcinoma of the cæcum itself, such growths being mostly in the lower end of the large intestine. In addition to the ordinary ileocæcal tumors he had one case which in addition to the ileocæcal tumor showed scattered lesions along the ascending and transverse colon. Nothing was done in this instance except the resection of the cæcum, as it would have required a large resection to remove the scattered foci, and so far as he knew they had not produced any subsequent bad results. In another case, supposed to be ileocæcal tumor, extending into the lower part of the ascending colon, the tumor, instead of being in the intestine itself, was found to be a mass of enormously enlarged glands lying mostly behind the colon and partly obstructing it. This patient was a child between thirteen and fourteen years of age. These cases of ileocæcal tumor lent themselves nicely to resection and the results were as a rule very satisfactory.

DR. JOHN A. HARTWELL called attention to a point brought out by Doctor Pool and that was that one had to make many sections before it could be demonstrated that tuberculosis was present in these cases. There was often no other evidence of tuberculosis except the chronic hyperplastic condition in the ileocæcal region, and the question he wished to raise was whether there might not be a form of chronic hyperplasia that was not tuberculous.

HYPERPLASTIC TUBERCULOSIS OF THE INTESTINES

Doctor Hartwell recalled a case in a young man twenty-one years of age in whom this condition existed in the terminal ileum, appendix and cæcum to about one-third the extent of the thickening that Doctor Pool's case showed. The wall was markedly thick but the lumen was not obliterated. The man was an Italian with little knowledge of English and it was difficult to get a satisfactory history from him. Operation was performed, a tight closure anastomosis being made. The examination showed the same type of hyperplasia described this evening. There was one penetrating ulcer within the diseased area. A number of sections were examined and no tuberculosis could be found.

A second case, which Doctor Hartwell recalled, occurred in a woman sixty-three years of age. She was seen two or three years before and it was thought there was something wrong in the region of the appendix and operation was advised. She then came under Doctor Hartwell's observation, and at operation it was found that the appendix was involved; it was thickened and there was an inflammatory exudate around the cæcum and ascending colon, and there were loops of smaller intestine adherent to the mass, so that it was necessary to resect two portions of the small intestine as well as a portion of the large intestine. In this specimen it was not possible to demonstrate tubercles. The specimen in the cæcal portion was very much like Doctor Pool's, and the question is "Does this disease arise in any other infection beside tuberculosis?"

DOCTOR POOL told of another case in which there was a chronic inflammatory hyperplasia in which he felt sure the ray fungus was present. He finally found a few threads of the ray fungus but not the rods themselves. In cases of this kind one should bear in mind the possibility of actinomycosis. Cases had been reported of lymphoblastomycosis in which sections were described as showing apparently a productive infiltration of this sort. He thought that if one searched with sufficient care in most of these productive infiltrations the tubercle bacilli could be found if they were not due to actinomycosis.

DR. CHAS. H. PECK asked whether there was not occasionally a type of hyperplasia that occurred in connection with diverticulitis where there was considerable hyperplastic thickening in the region of the diverticulum. He had not had any case of his own to substantiate this possibility, but would like to ask if others had any proof that such might be the case.

DOCTOR DOUGLAS said that reference had been made to the presence of a general peritoneal tuberculosis in connection with the intestinal lesion of the kind under discussion in only one of Doctor Erdman's cases. He could recall one case which he saw in the General Memorial Hospital six years ago, a young woman with a mass in the right inguinal region due to hyperplastic enlargement of the cæcum and ascending colon. There was present a large mass of glands and a miliary tuberculosis of both the parietal and visceral peritoneum in this region. It was not thought wise to attempt a radical operation, in view of the peritoneal lesion, so the patient was sewed

up. She lived in Jersey and he had heard later that she was apparently well without a resection ever having been performed.

DR. HERMANN FISCHER said he had had occasion within the last two weeks to operate on a patient, whom he had watched for six months. He had not succeeded in making the diagnosis and two excellent X-ray men had made a wrong diagnosis. They had made a diagnosis of ulcer of the duodenum. The symptoms were mostly confined to the epigastrium, the patient having complained of pain in the epigastrium, and there was a hyperchlorhydria. Both X-ray men reported that a defect was present that was probably a duodenal ulcer. The man gave a history of having lost weight and then after six months' internal treatment had gained fifteen pounds. During the last four weeks he had become much worse and had to give up work and go to a hospital.

At operation the abdomen was explored and the epigastrium. Nothing was found in the epigastrium, but in the ileocolic region there was a tumor. This was found to be a tuberculosis of the colon, as was shown by the evidence on microscopical and pathological examination. Another distinct tubercular ulceration and stenosis was found about one foot above the ileocaecal valve. An end-to-end anastomosis was done. On further exploration of the peritoneal cavity there were found about nine other tubercular strictures of the small intestine, scattered over an area of several feet of small gut. A resection of the ileum was not done as the condition of the patient was not good. A fecal fistula had formed after the operation, and the patient had lost ground continuously.

Doctor Fischer also recalled the case of a young girl whom he saw some ten years ago, at which time she had been ill for three days and was thought to be suffering from acute appendicitis with peri-appendicular abscess. The abscess was drained. She developed a fecal fistula after the operation and though she was in splendid health otherwise and had no other stigmata of tuberculosis, the granulation tissue of the fistula showed tuberculous tissue. The question of chronic actinomycosis was one that had to be borne in mind in dealing with these cases. In order to cure the fistula a secondary operation was done. As a resection was deemed too complicated on account of dense adhesions, a partial exclusion was done by an ileocolostomy. The result was very good—the fistula closed and the patient recovered entirely. He saw this patient a year after the operation, and at that time she was in good health. The tumor in the caecal region had entirely disappeared.

DR. ELLSWORTH ELIOT described a case supposed to be an ordinary inflammatory condition. At operation the appendix was found buried in the centre of the mass. The mass was at first supposed to be a carcinoma. The appendix could be enucleated together with a portion of the mass for subsequent microscopic examination. Neither showed either tuberculosis or carcinoma. The fact that this patient was alive and well to-day, twenty-five years after the operation, was clinical evidence of the benign character of the mass.

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Doctor Eliot said he thought the Mayos had collected and published a number of instances of supposed carcinoma of the sigmoid with a well-defined mass which microscopic examination some months after removal proved to be inflammatory or diverticular in origin.

Finally, Doctor Eliot said he thought it was not without interest to call attention to the type of anastomosis after resection of a tuberculous mass. He was inclined to favor the side-to-side anastomosis rather than the end-to-end anastomosis, because with the former postoperative obstruction was less likely to occur, and in a patient whose general condition, as was frequently the case in tuberculosis, did not favor an efficient repair of the suture line, side-to-side anastomosis was less likely to be followed by leakage than when end-to-end or end-to-side anastomosis was employed.

DR. JOHN F. CONNORS cited two cases in which the diagnosis of appendicitis had been made. At the operation a marked hyperplasia was found around the ileocæcal valve. A resection was done in both cases and the patients have remained well for the past five years. In one case the lesion seemed like an intussusception. A careful search pathologically failed to reveal either tuberculosis or actinomycosis. The cases were afterwards diagnosed by Dr. Otto Schultze as malignant ileocolitis.

DOCTOR ERDMAN, in closing, said that Doctor Hartwell had referred to simple chronic inflammation that might be taken for tuberculosis. He felt that in many cases classed as chronic inflammation without evidence of tuberculosis, a further search of many sections would reveal tubercles. The tendency among recent observers (Mickulicz, Berard and others) was to make tuberculosis account for many of the unclassified cases. In other words, if one found a hyperplastic tumor or cicatricial stenosis of the intestine which was not carcinoma it was quite likely to be tuberculous. Another point was that children might have a tuberculous enteritis which apparently healed and remained healed perhaps until they reached adult life and then they might be subject to this form of hyperplasia or to the formation of a stenosis. Doctor Peck had brought up his point with reference to the possibility of diverticulitis in the third case. This was the only case of the six that was not verified by actual microscopic evidence. However, in this case, a barium enema had been given, and a study of plates taken at intervals afterwards showed no evidence of diverticulitis. At operation the possibility of diverticulitis was considered and the sigmoid, ascending colon and rectum examined as far as possible and no diverticulitis found. Furthermore, on the surface of the tumor there were rather definite tubercles.

CORRESPONDENCE

BILATERAL CONGENITAL DISLOCATION OF THE HEAD OF THE RADIUS ANTERIORLY

EDITOR, ANNALS OF SURGERY:

The occurrence of bilateral congenital dislocation of the radius anteriorly is sufficiently rare to warrant reporting a case.

History.—A. R., male, of Italian birth. Insofar as could be determined this man was delivered by a mid-wife in a small township in Italy. At the time of his birth the parents noticed that both elbows were deformed and had somewhat limited motion. A surgeon was called in and advised against operative procedure. The man himself states that his brother has a congenital condition of the head, but he does not know the nature of the trouble. From this history it is probable that there is a family tendency to congenital malformations. Since coming to this country in early boyhood he has worked as a laborer, but has been severely handicapped because of limited power and motion in the left and right elbow-joints. He was inducted into the National Army on September 29, 1917, and at that time had stiffness in both elbow-joints. He was able to do his work in the army until March, 1918, when he injured his right elbow with a bayonet during drill. From the history it is apparent that he struck the right elbow with the butt end of the bayonet which resulted in a subacute process followed by further limitation of motion in the joint. He was given a discharge from the army July, 1918. At the present time he complains of stiffness and limited motion in both the right and left elbows.

Physical Examination.—Well-nourished male adult of small stature. No abnormalities can be found other than the surgical condition. Surgical condition, right upper extremity: There is distinct weakness in the grip of the right hand, the muscles of the forearm and the arm. Left upper extremity: There is slight weakness in the left hand, left forearm and arm. The motions at the elbow-joints in both right and left arms are tabulated below:

Motion	Right	Left
Flexion	Within 5° of normal	Normal
Extension	5° beyond right angle	Within 10° of normal
Pronation	Normal	Normal
Supination	Within 15° of normal	Nearly complete

A. Inspection.—Over the normal location of the head of the radius is a distinct depression and the head of the radius can be seen occupying a position below and in front of the external condyle of the humerus. This deformity is somewhat more marked in the right than in the left elbow.

FIG. 1.



FIG. 2.



FIG. 3.

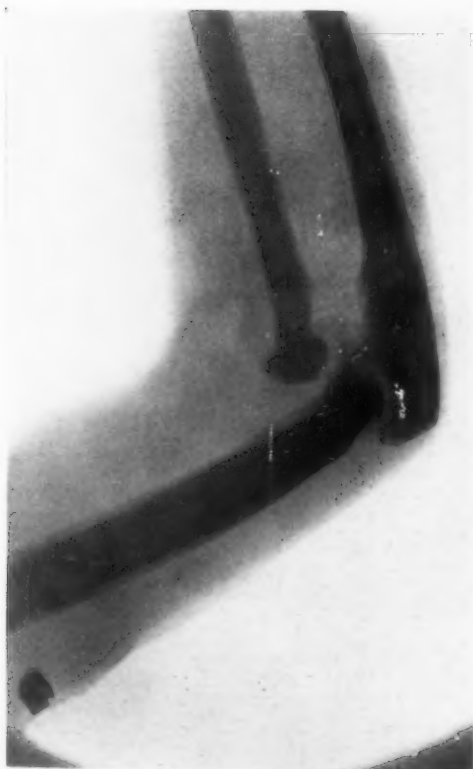
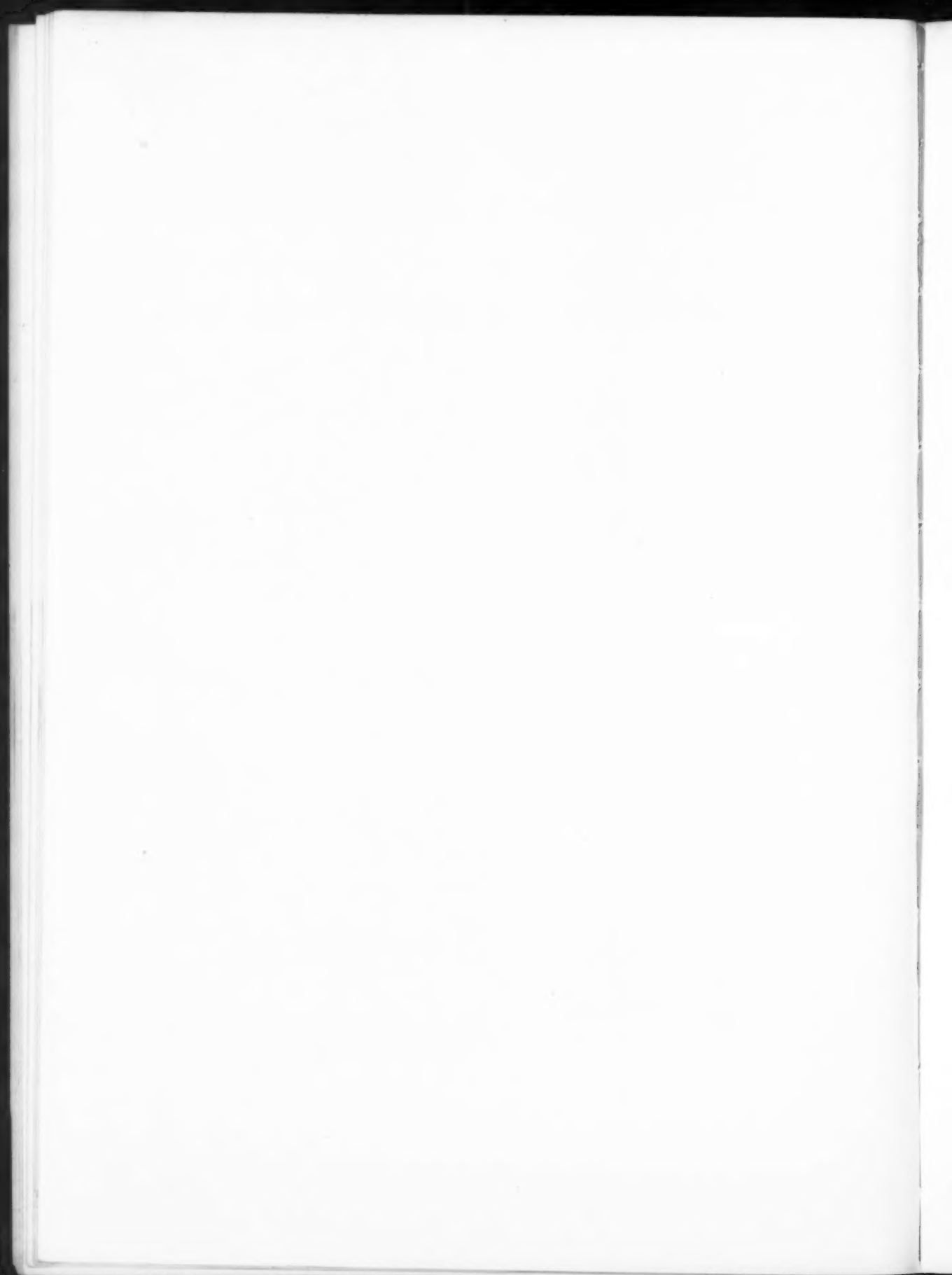


FIG. 4.



Bilateral congenital dislocation of head of radius anteriorly.



CORRESPONDENCE

There is considerable wasting and flabbiness of the muscles of the forearm and arm on both sides due to disuse.

B. Palpation.—Shows the head of the radius on both sides occupying a position below and in front of the external condyle of the humerus.

X-ray Examination.—By Byron C. Darling, M.D. The left elbow compared with the right: Both elbows show a congenital anterior dislocation of the heads and upper ends of the radii. Both are displaced forward approximately one inch, especially the right, which has apparently formed a false socket with the lower end of the humerus and less marked on the left side. This can be demonstrated under the fluoroscope with the forearm in acute flexion. There is no evidence of any present or past fracture or traumatic dislocation, or bone or joint disease.

The X-ray plates have been viewed by two other röntgenologists and the diagnosis concurred in.

Wassermann Reaction.—Negative.

Treatment.—Consultation with several New York surgeons showed them to be of one opinion, namely, that operative interference might possibly promise some small improvement, but that better surgical judgment called for conservatism in the form of baking and massage to increase motion in the elbow-joints.

WOODHULL L. CONDUCT,
New York City.

BOOK REVIEW

THE NOSE AND OLFACTORY ORGAN. The nose, paranasal passageways, and olfactory organ in man. A genetic, developmental, and anatomico-physiological consideration by J. PARSONS SCHAEFFER, A.M., M.D., Ph.D. 8vo. 370 pages. Philadelphia, Pa. P. Blakiston's Son and Co., 1920.

This volume is the result of studies which were begun in Cornell University in 1907, were continued at Yale, and recently completed at Jefferson Medical College. The object of the work is to present the very newest conception of the embryology, development, and anatomy (both micro and macroscopic) of the human nose, paranasal sinuses, and olfactory organ. The object has, indeed, been fulfilled. The author has spent thirteen years of constant and careful labor in the dissecting room and in the laboratory working out many of the hitherto obscure points in the embryology and anatomy of this very complicated organ. That there are still phases of the work that require further research, the author recognizes, particularly those which have to do with the development of the nerve tracts between brain and nose, in embryo. But at the present time the entire subject is certainly brought up to date in this book.

From time to time during the past thirteen years the author has presented papers covering some of the stages of his research. These were considered valuable as separate articles. Now, however, these monographs have been revised, rearranged, expanded, and compiled, and produced as one subject within one set of covers, not as a "review of the literature on the subject," but as a complete work for text and reference.

The volume is excellently produced. The print is large and clear. The plates, diagrams, photomicrographs, and especially the reconstructions are numerous and clear, and aid greatly in the comprehension of the different subjects under discussion.

The work is considered too advanced and detailed for the average undergraduate in medicine. It ought to be of the greatest value, however, to the student of anatomy, to the general surgeon, and particularly to the surgeon who has chosen the nose as his specialty.

MERRILL N. FOOTE.

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Remittances for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS of SURGERY

227-231 S. 6th Street

Philadelphia, Penna.

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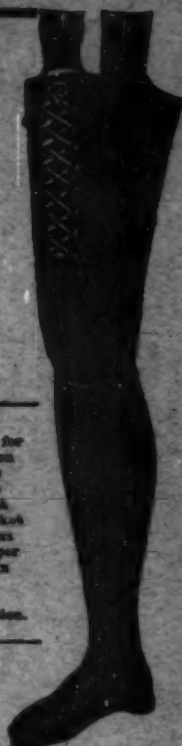
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